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Resource Management

AGR 1110

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Resource Management
AGR 1110

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Agriculture 1110
Resource Management
Student Module Booklet
Learning Technologies Branch
ISBN 0-7741-1393-6

This document is intended for	
Students	✓
Teachers	✓
Administrators	
Parents	
General Public	
Other	

The Learning Technologies Branch has an Internet site that you may find useful. The address is as follows:

http://ednet.edc.gov.ab.ca/ltb

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Welcome!

Welcome to AGR 1110.

We hope you'll enjoy your study of
Resource Management

CTS strands were designed to stand alone or be integrated with other strands for a customized course of studies to meet student needs. Through each strand, CTS basic competencies (knowledge, skills, and attitudes) will be identified as follows:

Careers: identify appropriate career linkages within the strand being studied

Communication: effectively present concise written, visual, and oral communications

Ethics: make judgements about whether behaviour is right or wrong on personal, community, and global levels

Innovation: recognize opportunities/problems and identify and suggest new ideas

Safety: assess potential risks, and follow personal and environmental safety procedures

Task Management: demonstrate an ability to locate and use resources and to use time effectively

Teamwork: work towards goals co-operatively, collaboratively, or independently, and acknowledge the opinions of others

Technology: effectively use technology when required

These basic competencies build daily living skills useful in a broad range of future endeavours and careers.

The eight icons that appear here indicate to students and facilitators that a basic competency has been identified in the activity offered to the students. Not all of the icons appear in each module.

Resources

- a notebook or binder in which to respond to the questions asked in this Student Module Booklet
- a VCR
- the following optional videotapes:
  - *Water in Alberta: The Living Flow Part I* and *Part II*
  - *Water, Water: Making the Most of Moisture*
  - *Concepts in Science—Photosynthesis—Seeing the Light*
  - *Oh Gully! Where Is the Soil?*
  - *Gone with the Wind, Too!*
  - *Nature's Legacy: Alberta's Grasslands and Parklands*
- your local library

Note that you may be required as part of this course to do outside research and to meet with business people in your community.

Visual Cues

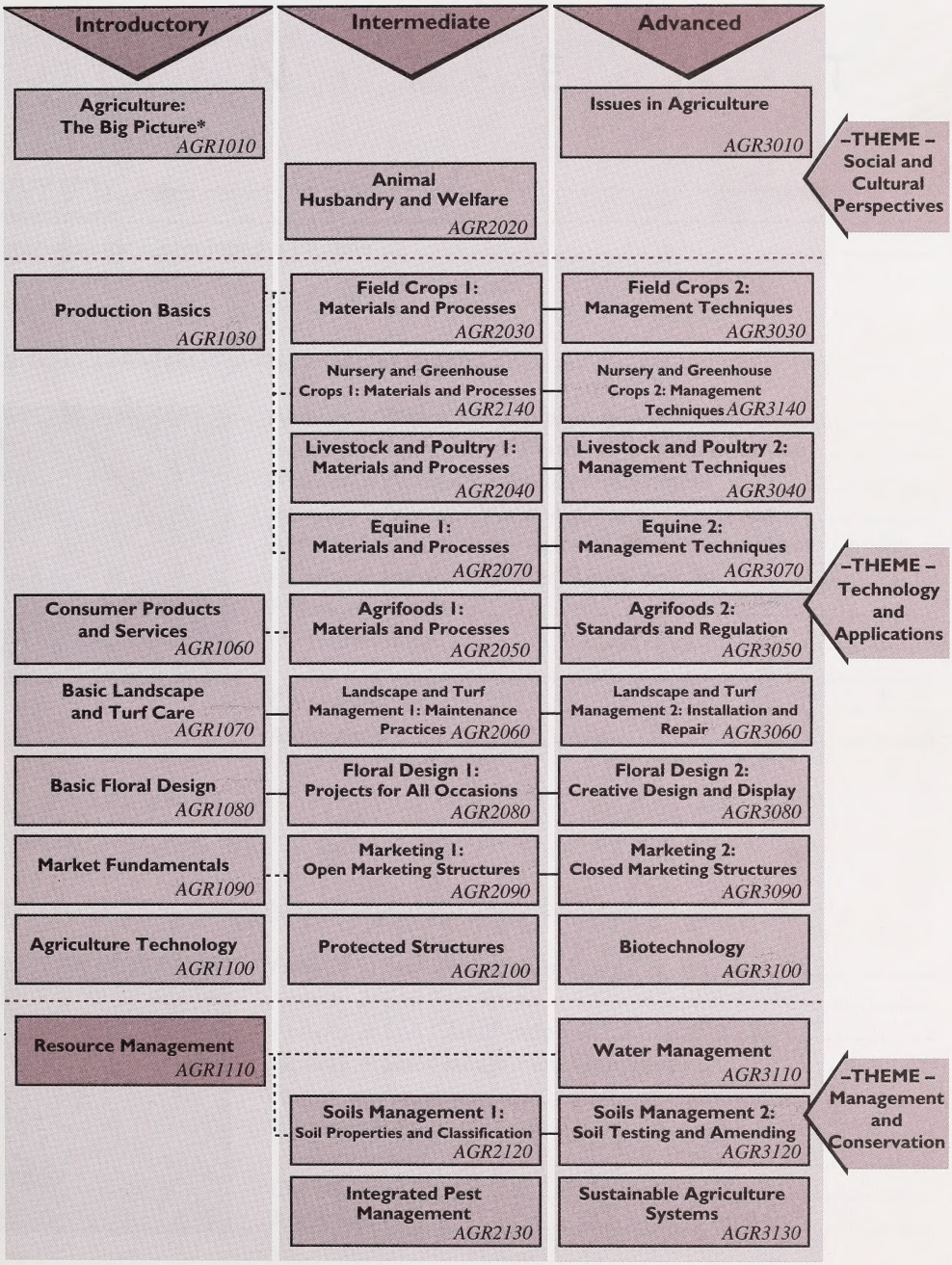
In addition to the Career and Technology basic competencies icons described earlier, you may find visual cues throughout the Student Module Booklet to assist you in your studies. Read the following explanations to discover what each icon prompts you to do.

View a videocassette.

Access the Internet (always an optional task).

Agriculture

O • V • E • R • V • I • E • W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Intermediate
Advanced
Agriculture: The Big Picture* AGR1010
Animal Husbandry and Welfare AGR2020
Issues in Agriculture AGR3010
–THEME – Social and Cultural Perspectives
Production Basics AGR1030
Field Crops 1: Materials and Processes AGR2030
Field Crops 2: Management Techniques AGR3030
Nursery and Greenhouse Crops 1: Materials and Processes AGR2140
Nursery and Greenhouse Crops 2: Management Techniques AGR3140
Livestock and Poultry 1: Materials and Processes AGR2040
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Equine 1: Materials and Processes AGR2070
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–THEME – Technology and Applications
Consumer Products and Services AGR1060
Agrifoods 1: Materials and Processes AGR2050
Agrifoods 2: Standards and Regulation AGR3050
Basic Landscape and Turf Care AGR1070
Landscape and Turf Management 1: Maintenance Practices AGR2060
Landscape and Turf Management 2: Installation and Repair AGR3060
Basic Floral Design AGR1080
Floral Design 1: Projects for All Occasions AGR2080
Floral Design 2: Creative Design and Display AGR3080
Market Fundamentals AGR1090
Marketing 1: Open Marketing Structures AGR2090
Marketing 2: Closed Marketing Structures AGR3090
Agriculture Technology AGR1100
Protected Structures AGR2100
Biotechnology AGR3100
Resource Management AGR1110
Water Management AGR3110
Soils Management 1: Soil Properties and Classification AGR2120
Soils Management 2: Soil Testing and Amending AGR3120
–THEME – Management and Conservation
Integrated Pest Management AGR2130
Sustainable Agriculture Systems AGR3130

— Prerequisite --- Recommended sequence

* Module provides a strong foundation for further learning in this strand

June 1997

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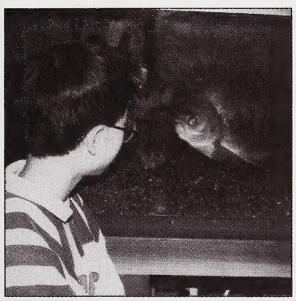

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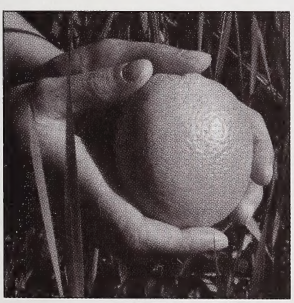

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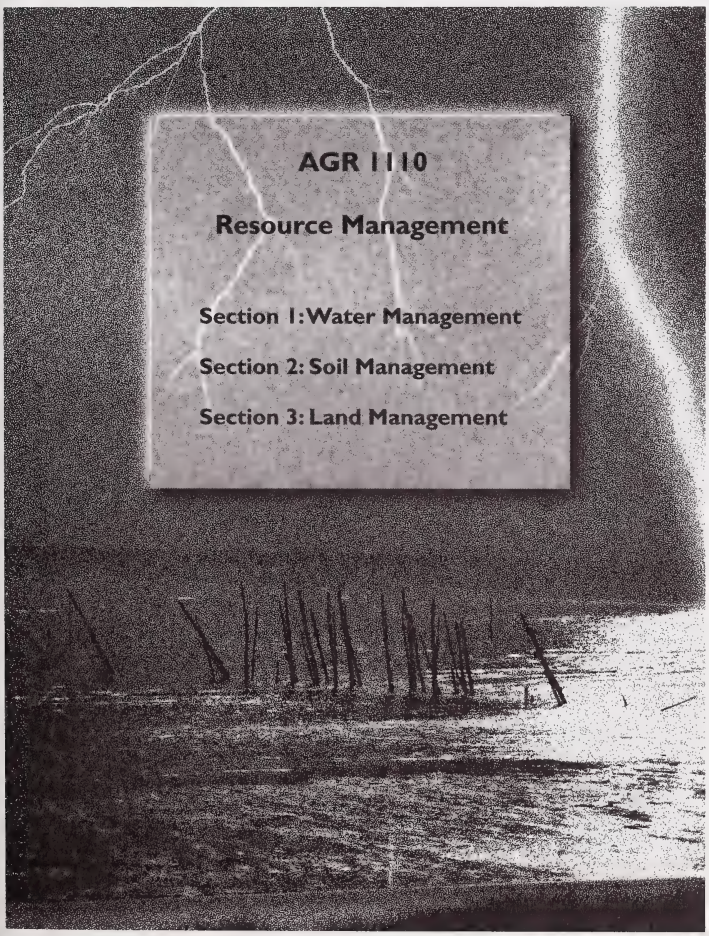
Resource Management

O • V • E • R • V • I • E • W

Suppose you've been given a gift. There are three parts to the gift and they are equally important. If you take care of this gift, there could be many rewards. If, however, you don't take care of this gift, the consequences could be severe—they may even affect other people. You might not realize it, but you already have this gift. It consists of water, soil, and land.



Water, soil, and land are three resources that are very important in Alberta. The agriculture industry in Alberta depends on these three resources to supply you with the basics of life. It is essential, therefore, that these resources are carefully managed. If they aren't properly managed, the effects could be harmful to the agriculture industry and to society as a whole.

In this module you will examine water management, soil management, and land management. In the first section, you will discover what water resources are available in Alberta and how those resources can have an impact on life. In the second section, you will investigate soil resources and look at soil-management techniques. In Section 3, you will explore land-use issues. You should look for articles or news items on water-, soil-, and land-use issues. Gathering information from outside sources will increase your understanding of the concepts explored in this module.

Assessment

The document you are presently reading is called a Student Module Booklet. It will show you, step by step, what to do and how to do it.

This module, Resource Management, is worth one credit. The module is comprised of three sections. Within each section, your work is grouped into activities. Within the activities, there are readings, explanations, and questions for you to work through. You will correct these activities yourself using the Appendix at the end of this module. These suggested answers will provide you with immediate feedback on your progress.

A portion of your grade in this module will be based on the assignments that you complete for assessment. There is one assignment after each section. The mark distribution is as follows:

Section 1 Assignment	**33 marks**
Section 2 Assignment	**35 marks**
Section 3 Assignment	**32 marks**
TOTAL	**100 marks**

The CTS modules are competency based, which means that you must successfully complete each section to receive credit for the module.

In addition, you might also be required to complete a final test. The weighting for this final test will be determined by your teacher.

Strategies for Completing a Module

Organize your materials and work area before you begin: Student Module Booklet, textbook, notebook, pens, pencils, and so on. Make sure you have a quiet area in which to work, away from distractions.

Because response lines are not provided in the Student Module Booklet, you'll need a notebook or lined paper to respond to questions and complete charts. It's important to keep your lined paper handy as you work through the material and to keep your responses together in a notebook or binder for review purposes later.

To achieve success in this module, be sure to read all of the instructions carefully and work slowly and systematically through the material. Remember, it's the work you do in this Student Module Booklet that will prepare you for your assignments. Try to set realistic goals for yourself each day; and when you've set them, stick to them. Do your assignments regularly, and don't forget to review your work before handing it in. Careful work habits will greatly increase your chances for success in Agriculture.

Good luck!

Water Management

HAVE you ever kept fish in an aquarium? Compared to keeping some other pets, keeping fish seems relatively simple. You don't need a large area to keep them in, and you don't need to build a pen or cage. You just put them in an aquarium filled with water and they are fine, right? Actually, it's a bit more complicated than this. Besides feeding the fish, you also have to monitor the conditions of the water. You have to ensure that the water is clean with the correct amounts of air and algae in it. The water in the aquarium must have certain features or the fish will die.

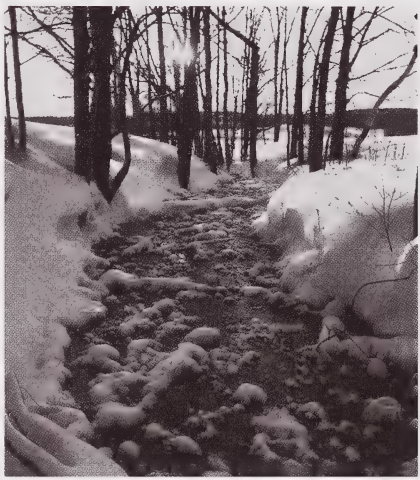
Just as managing water is important in an aquarium, so is managing water in a place like Alberta. In Alberta, it isn't only fish and other aquatic animals that rely on a clean supply of water. All plants, animals, and people need fresh, clean water in order to survive. Water is especially important to the agriculture industry since the agriculture industry helps provide many of the essentials of life—particularly food.

In this section, you will discover what water resources exist in Alberta and what makes water suitable for agricultural use. You will compare techniques for managing water and examine what the Alberta government is doing to aid the preservation of the province's water resources. You will also look at the effects of agricultural practices on water quality, and you will study the impact of the water supply on life. Finally, you will examine practical strategies for water management.

SECTION 1

ACTIVITY 1

Water Resources in Alberta



How much useable water is there in Alberta? To answer this question, consider this analogy. If all the world's water supply could fit into a 4-L milk container, then just over
15 mL would represent the amount of fresh drinking water. The amount of drinking water found in Alberta would be equal to a single drop.

Where does the water you use come from? In this activity, three sources will be discussed: precipitation, surface water, and ground water.

Precipitation

Precipitation is the main source of useable water. Rain and snow provide most people with the water they use each day. Precipitation also provides crops with water. It flows into dugouts, streams, and lakes that might be used to water livestock. Precipitation is influenced by landforms and air currents. Since different areas in Alberta have different landforms and air currents, the rate of precipitation differs across Alberta.

Much of the precipitation falling in Alberta comes from the Pacific Ocean. Water evaporates from the ocean surface. Warm air carries it up into the atmosphere. Air currents push the moist air over the Rocky Mountains. As the moist air moves up, it cools and the water condenses to form clouds. Eventually, moisture gathers together to form raindrops or snowflakes that fall to Earth.

Precipitation rates are highest in mountain ranges and foothill areas. Moist air continues to lose moisture as it moves eastward across the prairies. Consequently, inland areas receive less precipitation than those closer to the mountains.

Refer to the map showing the Mean Annual Precipitation in Alberta, which can be found in the Maps section of the Appendix.

The map shows the greatest amount of precipitation falls in the Rocky Mountains. The areas receiving the least amount of precipitation are on the eastern edge of the province—east of Drumheller and south of Medicine Hat.

Most of Alberta's precipitation falls during the summer months. That is because warm summer temperatures induce more evaporation, which means more water moves into the atmosphere. Since warm air has a greater capacity to carry moisture, more water is transported over the Rocky Mountains.

The Rocky Mountains are the largest landform affecting Alberta's precipitation. However, Alberta does have other features that influence precipitation rates in a similar fashion. For example, more precipitation falls on the Caribou Mountains, the Stony Mountains, the Swan Hills, and the Cypress Hills than on surrounding areas. Look at the mean annual precipitation map and you will see these areas stand out.

Air currents also influence where and how much precipitation falls on an area. Look at the Summer Air Flows in Alberta map in the Appendix.

In the summer, cool, moist air blows in from the northwest corner of the province and sweeps across northern Alberta. In central regions, mild air moves from west to east, alternately dropping and picking up moisture as it does so. In southwestern Alberta, moist air moves up along the Rocky Mountains before peeling off and heading eastward. In the southwest corner of the province, warm, dry air moves northward before gently curving eastward.

1. Fill in the following chart using the information given on the maps Mean Annual Precipitation in Alberta and Summer Air Flows in Alberta. The information for Red Deer has been completed for you.

Community	Precipitation Range (mm)	Region (west, central, east)	Closest Summer Air Flow
Red Deer	457 – 508	central	between moist and dry
Kananaskis	610 +		
Hinton	508 – 559		
Edmonton		central	
Grande Prairie			mild
Calgary	406 – 457	west	
Lethbridge		central	
Medicine Hat			

2. How would the province's weather patterns be affected if the Rocky Mountains didn't exist?

Compare your answers with those in the Appendix, Section 1: Activity 1.

Surface Water

Surface water is the most visible source of water. Examples of surface waters include the following:

- streams
- rivers
- ponds
- lakes
- dugouts
- canals
- reservoirs

Surface waters are arranged along ancient drainage paths. These drainage paths developed as melt waters from the last glaciers made their way to ancient seas. Surface waters collect and flow along these drainage paths to three destinations: Arctic Ocean, Hudson's Bay, and Gulf of Mexico.

The Athabasca River, Peace River, Slave River, and Hay River systems collect waters that end up in the Arctic Ocean. The North Saskatchewan River, Red Deer River, and South Saskatchewan River systems collect water that flow to the Hudson's Bay. The Milk River system is the only drainage system in Alberta that collects water that eventually ends up in the Gulf of Mexico.

Refer to the Lakes and Rivers in Alberta map found in the Appendix.

Notice the largest lakes are located in the northern half of the province. The five largest lakes are Lake Athabasca, Lake Claire, Lesser Slave Lake, Bistcho Lake, and Hay Lake. Note that only one third of Lake Athabasca is located in Alberta; the rest of this large lake is located in Saskatchewan.

The central part of the province has several smaller lakes including the following:

- Chip Lake
- Lac St. Anne
- Wabamun Lake
- Beaverhill Lake
- Pigeon Lake
- Gull Lake
- Buffalo Lake
- Sullivan Lake

There are just a few natural lakes in the southern part of the province; Lake Newell and Pakowki Lake are shown on the map. Because there are so few natural water bodies in the southern part of the province, and because it is drier there than other parts of the province, several dams have been constructed on rivers and streams. Water collects behind the dams; these human-made lakes are called reservoirs. The Oldman River Reservoir and the St. Mary Reservoir are shown on the map.

Agriculture uses surface waters extensively. Water from dugouts, ponds, streams, rivers, lakes, and reservoirs are used to raise animals and grow crops.

Surface water is also used extensively to process raw agricultural goods into consumer goods. For example, water is used as an ingredient in making bread. It is also used to clean materials and equipment. Furthermore, it is often used in cooking processes.

Surface waters are used by most communities for drinking water. Get a map of Alberta and look at where the major cities are located. You will notice that each city is located near or on a fresh water source. In most cases it is a river. That is not a coincidence. The fact is that people need water. They live in places that can supply that need. Look at a map of any other country. You will see the same pattern. For example, the following large communities are located on or very close to sources of surface water:

- Paris—Seine River
- Berlin—Spree River
- Delhi—Jumna River
- Beijing—Lianhua, Nan Chang, and Tonghui River

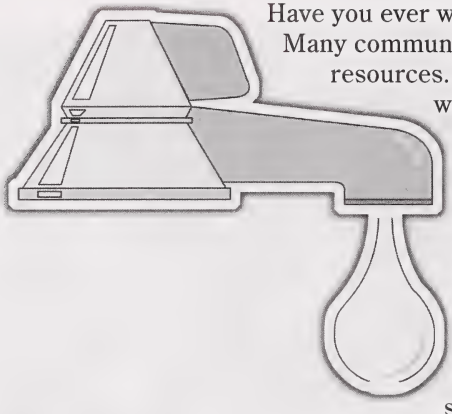
Task Management

3. List the sources of water located around your home.

4. Why do you think the major cities in Alberta are located where they are?

Compare your answers with those in the Appendix, Section 1: Activity 1.

Ground Water



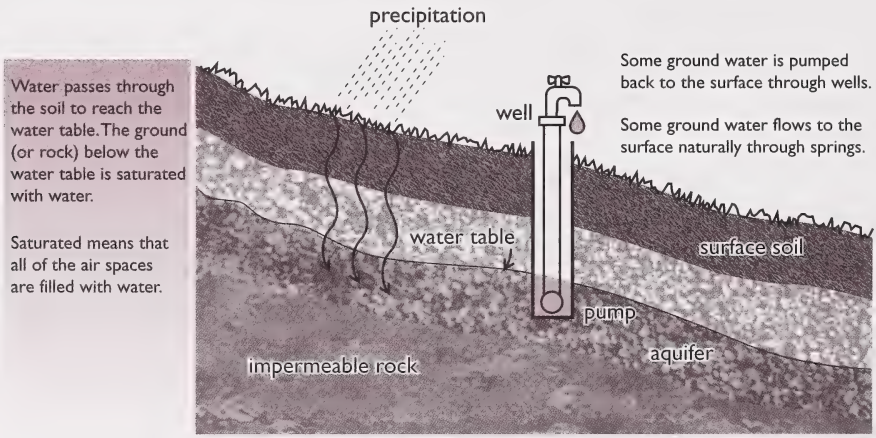
Have you ever wondered where tap water comes from? Many communities draw water from surface water resources. However, there are people who get their water from wells. Wells tap into water resources located below Earth's surface. These water resources are know as ground waters.

Ground water collects in layers of porous materials, like sand and unconsolidated rock. Porous materials have relatively large spaces that can fill with water. The spaces are interconnected so water moves through the porous materials easily. Porous layers that are saturated with water are known as **aquifers**.

▼
aquifers: *subsurface layers of porous material that collect, store, or transmit water*
▲

Ground-water aquifers are located at various depths below the surface. The upper boundary at which water is located below the surface is known as the water table.

Ground-Water Source


precipitation
Water passes through the soil to reach the water table. The ground (or rock) below the water table is saturated with water.
Saturated means that all of the air spaces are filled with water.
well
Some ground water is pumped back to the surface through wells.
Some ground water flows to the surface naturally through springs.
water table
surface soil
pump
aquifer
impermeable rock

Some ground water remains underground for hundreds or even thousands of years before returning to the surface and re-entering the water cycle.

Rock or ground that can store and transmit water is called an aquifer.

People draw water from wells for their domestic use as well as their commercial use. Examples of commercial use are irrigating crops and watering livestock.

The trouble with wells is that they can go dry and it is difficult to tell when that will occur. What happens is that the water level in the aquifer drops below the intake pipe. If the area around the intake pipe is not replenished with water, the well will remain dry. Extending the pipe further into the aquifer may lead to more water, but in some cases the aquifer is simply too dry to allow for any further withdrawal.

5. State in your own words what an aquifer is.

Compare your answer with the one in the Appendix, Section 1: Activity 1.

In this activity you looked at the available water resources in Alberta. The three main water sources discussed were precipitation, surface water, and ground water. Each plays a part in supplying agricultural needs.

ACTIVITY 2

Suitability of Water for Agricultural Use

Water used in agriculture must be relatively clean. Plants and animals can tolerate a certain amount of foreign material in their water but not much. Waters with high concentrations of minerals like mercury and arsenic can cause health problems. Impurities like salts can inhibit plant and animal metabolisms. Bacteria in water can also lead to health problems for plants and animals. Therefore, the water most suited for agriculture is close to being pure.

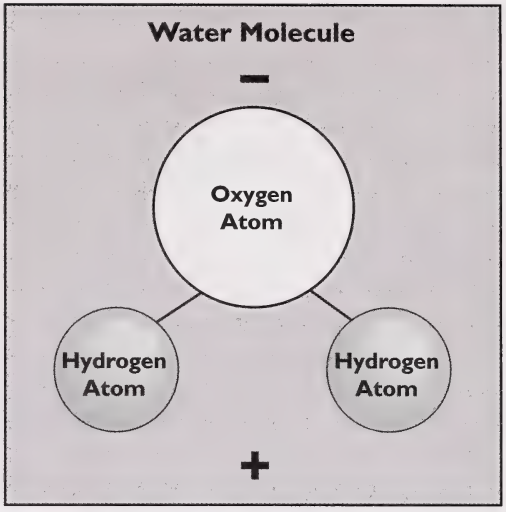
The trouble is that waters on Earth are constantly picking up impurities. The longer water sits in one place, the more prone it is to picking up minerals, salts, and **pathogens**. In this activity you will look at how water becomes suited for agricultural use.

▼
pathogens: *viruses or bacteria that cause diseases*
▲

Water

Water is the most common liquid on Earth. Three-quarters of Earth's surface is covered by water. Water, however, should not be considered ordinary; in fact, it is extraordinary. Without it, life on Earth wouldn't be what it is.

What gives water its unique properties? Water is a compound made up of two common elements. The molecular structure of water is H_2O, which means that each molecule of water is made up of two hydrogen atoms and one oxygen atom. The following diagram gives you an idea of what a single molecule of water might look like.



Water also has the ability to change states. The three states of water are solid, liquid, and gas. Of all the water on Earth's surface, 98% is in liquid form. Some of the remaining 2% is in a solid form (ice glaciers and polar icecaps), and some is in the atmosphere in gaseous form as water vapour.

Water freezes and reaches its solid state when the temperature drops to 0° C. When water freezes, it expands and takes up more volume than it does as a liquid. That makes ice less dense than liquid water and, therefore, it floats.

It takes energy to change water from a liquid into a vapour. That is why evaporating water cools your skin. It is absorbing heat energy as it goes from liquid to vapour.

1. List the three states that water can take. Give an example of each water state found in your home.

Compare your answer with the one in the Appendix, Section 1: Activity 2.

Water for Agriculture

As stated earlier, agriculture requires fairly pure water. Plants and animals need fresh, clean water to survive. This poses a problem because water on Earth's surface pick up foreign materials that can make it undesirable for agricultural use. Therefore, for life to continue on Earth, waters must be continually refined and cleaned, which is what happens during the **water cycle**.

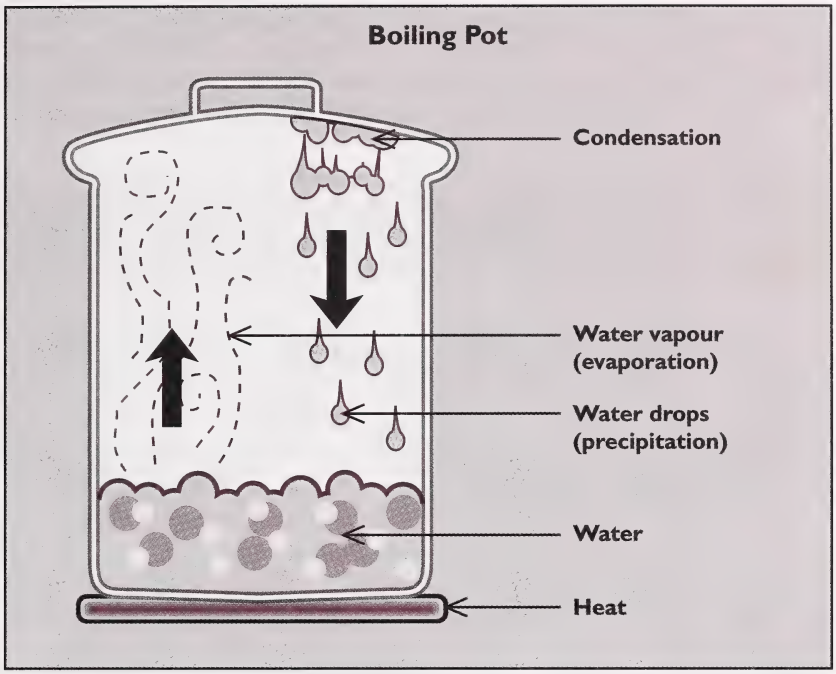
▼

water cycle: *the circulation of water on Earth through three stages: evaporation, condensation, and precipitation*

▲

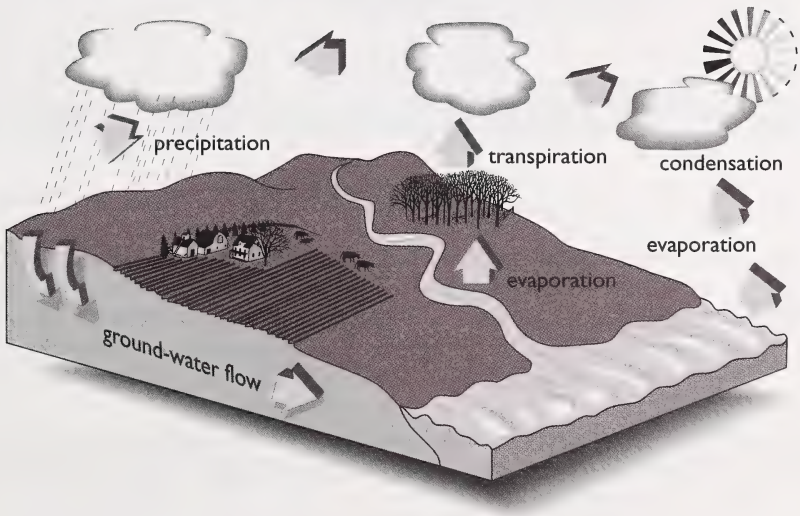
The Water Cycle

Water goes through several stages on Earth. Because water goes through each stage in sequence and repeats the sequence, the process is called the water cycle or hydrologic cycle.



To help you understand the water cycle, consider a simple example. Picture a pot of water boiling on the stove. At the boiling point, water begins to evaporate, changing from a liquid state to a gaseous state called water vapour. Some of the water vapour condenses on the pot's lid forming water droplets. The droplets enlarge and then fall back into the pot.

Water Cycle



The processes going on in a boiling pot are similar to those in the water cycle. Heat transmitted by the sun evaporates water in seas, lakes, and rivers to form water vapour, just like the heat from the stove causes water in a boiling pot to form water vapour. Evaporation also takes place from sun-warmed soils and perspiring animals.

Did you know that the sun evaporates almost half a million cubic kilometres of water from the oceans annually?

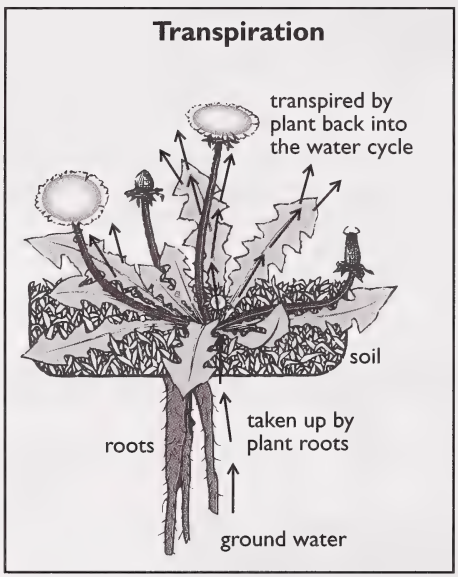
▼

transpiration: *the passage of water vapour from a living body through a membrane or pore*

▲

A great deal of water vapour comes off plants through a process called **transpiration**. Transpiration is the process in which plants eliminate excess water through pores in their leaves.

Have you ever used a siphon to move water from one pail to another? The difference in pressure you create by sucking on the lower end of a tube pulls water through the tube. That difference in pressure is maintained as long as water continues to move through the system.



A similar thing happens in a plant. Water enters the root system. It moves up the plant stem through veins; then it enters the leaves. Water evaporates from the leaves. That creates a void, which pulls more water up from the roots.

A great amount of water is processed in this manner. A single corn plant may transpire over 200 L of water in its life from seed to harvest. Over the course of a growing season, 0.4 ha of corn requires almost 2 000 000 L of water to produce a mature crop. More than 90% of that water is transpired.

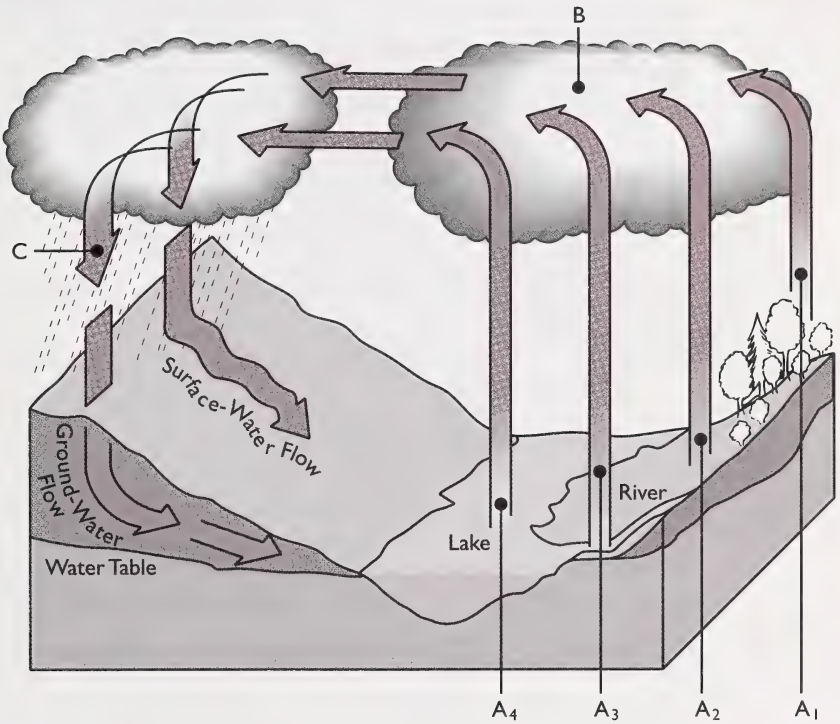
Water vapour travels along with air currents in the atmosphere. Usually, warm air moves upwards. As it does so, it cools and so does the water vapour. Cooling brings the water particles together; they condense into larger particles forming clouds. A similar thing happens inside a boiling pot of water. Water vapour rises into the air and then condenses on the pot lid.

When water particles in clouds get large enough, they fall to Earth as precipitation, just like drops of water that form on a boiling pot lid fall into the pot when they get large enough.

▼
rills: *very small streams of water*
▲

Once water is back on Earth's surface, it either moves across the ground to form **rills**, streams, and rivers or it accumulates in puddles, ponds, and lakes. Some of the water falling back to Earth moves into, or infiltrates, the soil to become ground water.

2. Identify what is happening at points A1, A2, A3, A4, B, and C on the following diagram of the water cycle. Describe what is taking place at each point in the diagram of the water cycle.



Compare your answers with those in the Appendix, Section 1: Activity 2.

Refining Water Through the Water Cycle

When water goes through the water cycle, it is purified again and again. Impurities that were picked up while in the liquid state are left behind during the evaporation process. The purified water condenses and falls back to Earth as precipitation. Rain water contains few impurities; therefore, it is the best water source for agricultural purposes.

Water sources with characteristics similar to rain water are used in agriculture. Surface waters and ground waters that are relatively clean are also suitable for agricultural purposes.

A very big concern is that air pollution is altering the purifying properties of the water cycle. Air pollutants like hydrogen sulphide gas become dissolved in raindrops, contaminating them and making rain water less suitable for plants and animals.

In this activity you investigated where water comes from and a few of its physical properties. You should be able to describe the water cycle and be able to identify several sources of water vapour. You should also be aware that it is through the water cycle that water is made fit for agricultural use.

ACTIVITY 3

Water-Management Techniques

Managing Too Little Water

The Climatic Map of Alberta, found in the Appendix, indicates there are two areas in the province where lack of moisture is a limiting factor for plant growth. Areas 2A and 3A usually have fertile soils and long enough growing seasons to grow crops, but they don't get enough precipitation to achieve maximum yields.

Use the Climatic Map of Alberta to answer the following questions.

1. Locate your home on the map. Is rainfall a limiting factor for crop growth in your area?

2. In which of the following places is rainfall a limiting factor for plant growth?

   - Peace River
   - Edmonton
   - Calgary
   - Lethbridge
   - Medicine Hat

3. What do you think causes the problem of too little moisture around Medicine Hat? Suggest two reasons.

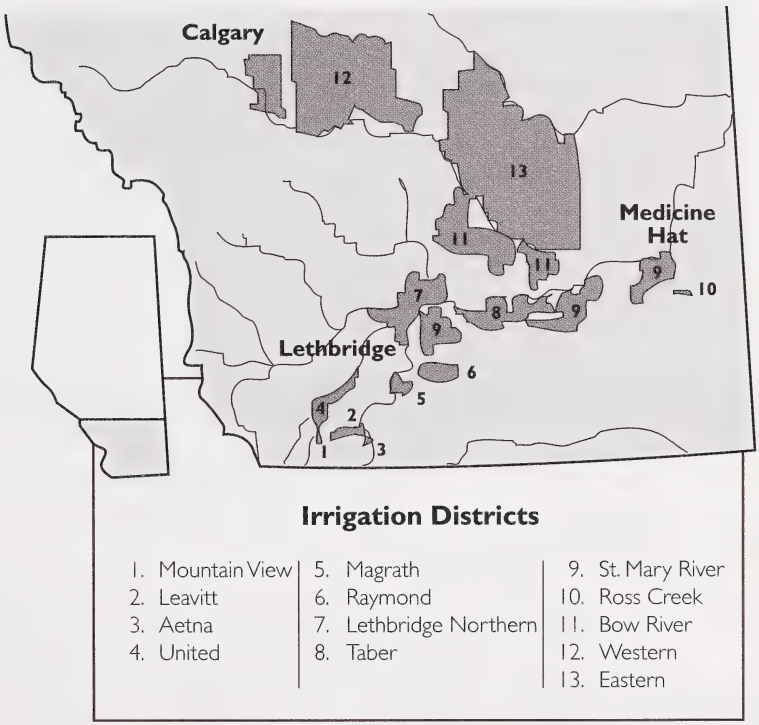
Compare your answers with those in the Appendix, Section 1: Activity 3.

In areas where moisture is a limiting factor for crop growth, farmers have two options. They can irrigate or they can conserve available moisture.

Irrigation

Irrigation is a method of artificially watering lands. You learned earlier that dams were constructed in the southern part of the province to create water reservoirs. A system of canals moves the water from these reservoirs through thirteen irrigation districts. The irrigation districts are shown on this map.

Alberta Irrigation Districts



Irrigation Districts

1. Mountain View
2. Leavitt
3. Aetna
4. United
5. Magrath
6. Raymond
7. Lethbridge Northern
8. Taber
9. St. Mary River
10. Ross Creek
11. Bow River
12. Western
13. Eastern

Two irrigation techniques can be used to move water from the canals to growing plants. One is called gravity irrigation and the other is called sprinkler irrigation.

Gravity Irrigation

Gravity irrigation uses the natural forces of Earth's gravity to move water onto fields. Water flowing through the main irrigation canals is diverted to fields using control devices called gates. The diverted water then flows downhill over the field.

There are two methods of gravity irrigation. First is the border dyke method. This method uses ridges of soil constructed in parallel lines down the field to control the flow of water over the crops.

The second is the furrow method. This method uses small ditches to channel water between rows of crops. Water is siphoned through rubber tubes from a concrete-lined ditch at the edge of the field. Then the force of gravity spreads the water over the field.

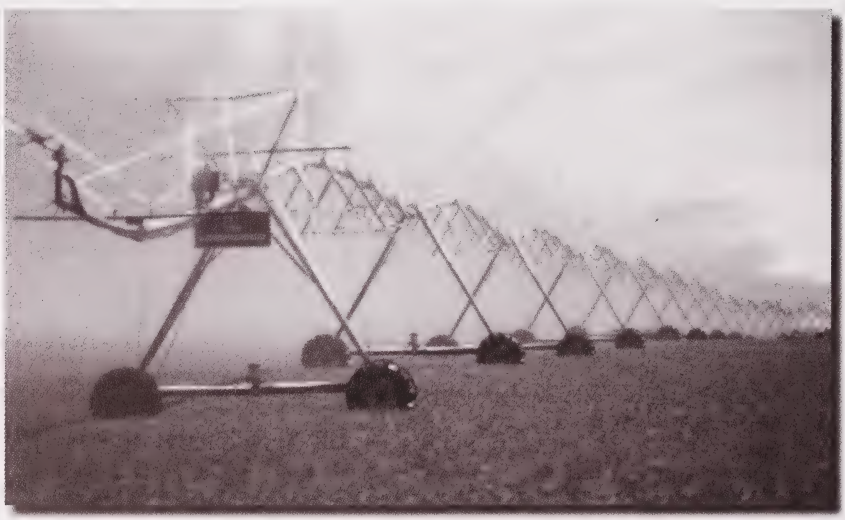
Gravity irrigation is simple to use and inexpensive, as it does not require a great deal of equipment. However, this method does require work. Farmers must closely supervise the irrigation process to ensure that all parts of their fields receive adequate water, taking care not to overwater them. In Alberta, the gravity method is not used extensively. It is more appropriate for smaller fields with row crops.

Sprinkler Irrigation

Sprinkler irrigation is the type of irrigation system with which you are probably most familiar. It works on the same principle as the sprinkler you use at home to water your lawn or garden. Water is pumped through pipes from the irrigation canals and then sprinkled on fields like a rain shower. Sprinkler irrigation is more costly than the gravity method because it requires more equipment.

There are two common methods of sprinkler irrigation. One is the side-wheel-roll method, which is also known as the wheel move system. This method consists of a pipe suspended by wheels about a metre off the ground. Water is pumped through the pipe and sprayed onto growing crops. The whole system is moved by a motor located at its centre. The centre pipe acts as an axle. The usual length of a wheel-roll system is 400 m.

Although this is an effective method of providing crops with the required moisture, there are some problems. One major drawback of this type of irrigation is that it can only be used on crops that grow less than a metre in height. Taller crops prevent the system from moving.



AAFRD, CONSERVATION AND DEVELOPMENT BRANCH

The second sprinkler system, which is shown in the preceding photo, is the centre-pivot method. In this method water is pumped through pipes to sprinklers mounted 2 m to 3 m above the ground. The whole system is connected to a point in the middle of the field. The equipment moves automatically around the centre point spraying water as it does so. Centre pivots can cover large fields and are suitable for use on all crops grown in Alberta.

This method of irrigation is effective; however, it has some disadvantages. For example, centre-pivot irrigation does not water the corners of square fields. As a result, crop yields are much lower in the corners than in other parts of the field. Aerial photos of fields with centre-pivot irrigation clearly show this.

Another drawback, which affects both methods of sprinkler irrigation, is that much water is lost due to evaporation. Even so, irrigation is very important to agriculture in Alberta. The importance can be detected in production statistics. On average, 20% of Alberta's gross farm income is drawn from irrigated land even though it represents only 4% of the useable land in Alberta.

4. The gravity methods of irrigation are not widely used in Alberta. Give one reason why this is the case.

5. In paragraph form, describe an irrigation method. Give one advantage and one disadvantage for this method.

Compare your answers with those in the Appendix, Section 1: Activity 3.

Conserving Available Moisture

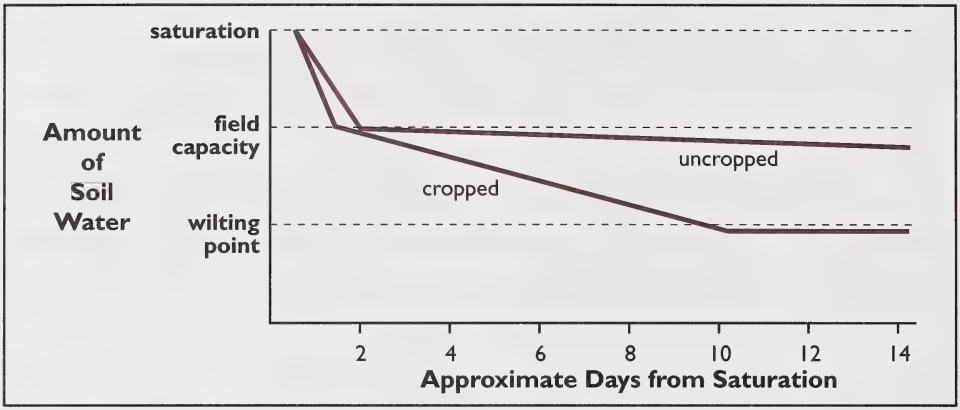
What can a farmer do if moisture is a limiting factor in crop production and irrigation waters are not available? The farmer must look at conserving available moisture.

One of the oldest conservation practices is the technique of summerfallowing. Summerfallowing is a practice that allows the land to rest for one growing season. Farmers leave the land for an entire growing season without planting a crop. As you have already learned, growing plants use a great deal of water. If plants are not grown in a field, the soil moisture builds up for the next growing season.

Summerfallow fields are cultivated or sprayed with herbicides to ensure the soil moisture is not depleted by weeds.

The following graph compares soil moisture available to crops in two different fields. One was summerfallowed; the other was cropped. As you can see, the land that was summerfallowed retains more moisture.

Comparison of Summerfallow Cropping on Soil-Water Content



▼

saturation: *the point at which the soil can hold no more water*

The excess drains off.

field capacity: *the point at which the soil holds its maximum amount of water*

wilting point: *the point at which soil holds so tightly onto water that plants cannot get enough for their use*

stubble: *crop stems left standing after harvest*

▲

One of the newest techniques for conserving soil moisture is a procedure called zero tillage. Under zero tillage, seeds for a new crop are planted in soil that hasn't been cultivated. That means the **stubble** from the previous crop has not been worked into the soil. A special seeder is used to cut through the stubble and plant seeds beneath the soil surface. Zero tillage conserves valuable soil moisture and reduces erosion at the same time.

Farmers can also conserve moisture by trapping winter snowfalls. They can do this by leaving plant residue on their fields. Stubble, especially stubble of different heights, holds the snow during the winter. When the snow melts in the spring, stubble and other plant materials block the flow of water from the fields. Retaining water longer means more water is absorbed into the soil.

Another way to retain melt waters is to construct small dams along natural waterways in a field. The resulting flooding gives water additional time to seep into the soil.

Did you know a snowfall of 10 cm brings about the same amount of moisture as 1 cm of rainfall?

6. List three methods that farmers can use to conserve moisture on their land.

Compare your answer with the one in the Appendix, Section 1: Activity 3.

Managing Too Much Water

You have learned how to manage a scarcity of water. Now you will study ways to deal with too much water.

Several problems can be traced to too much water. One is crop damage. If soil becomes oversaturated, plants will not grow properly and may actually drown.

Another problem is that too much water interferes with field work. Too much precipitation in the spring can delay seeding, thus shortening the growing season. Too much precipitation in the fall can delay harvesting, which can result in lower-quality grain being harvested. Too much water at other times can make field work impossible so that weeding and fertilizing operations are missed.

A third problem is that too much water can lead to soil erosion. Excess waters can carry off tonnes of soil particles. Rills and streams can cut deep gullies in fields. The eroded material can build up and clog canals and streams, which may lead to unwanted flooding. Clogged canals need dredging so that they can function when water is needed.

These problems lead to reduced efficiency and reduced crop yields. The end result is reduced incomes for farmers.

7. Name three problems associated with too much water.

Compare your answer with the one in the Appendix, Section 1: Activity 3.

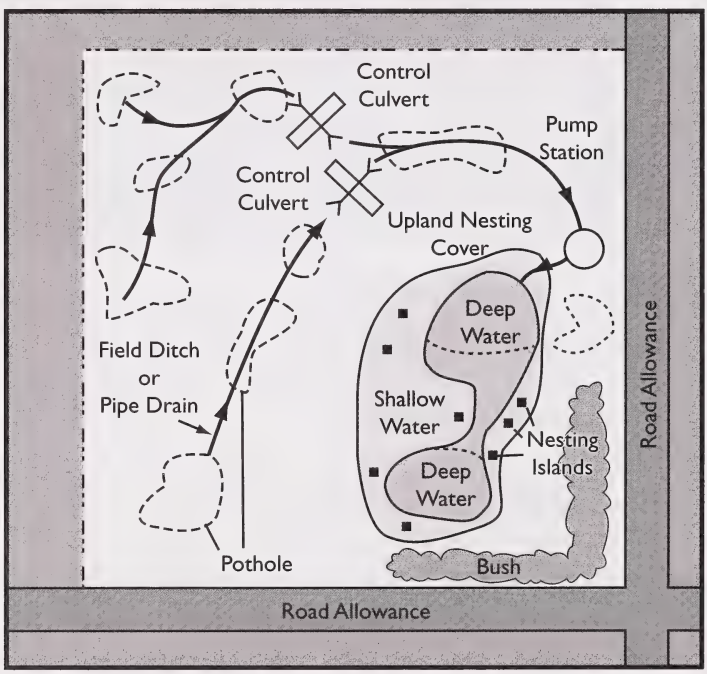
Too much water can come by way of heavy and persistent rainfalls or poor drainage systems. What can be done about these situations? Although there is very little that can be done about too much precipitation, something can be done to enhance drainage systems.

Drainage Techniques

Proper drainage systems allow excess water to move off fields without causing much damage. One way to manage excess waters is to consolidate small sloughs or potholes into large ones. This makes it possible to utilize areas that would not otherwise be useful. It also increases the efficient use of machinery. Draining potholes makes it possible to run machinery straight through low spots rather than manoeuvering around them. This saves time and energy.

Farmers can use ditches or pipes to move water from one spot to another. The diagram that follows illustrates a water management and drainage system on a farmer's property.

Field Drainage System



▼

arable: *suitable for tilling or cropping*

▲

A proper drainage system gives a farmer more **arable** land, as well as a larger source of water, which can be used for other things like watering livestock or wildlife habitat.

Innovation

8. What effect would consolidating small sloughs and ponds in a field into a single water body have on the following?

   a. agricultural production
   b. wildlife habitat

Compare your answers with those in the Appendix, Section 1: Activity 3.

You should now know a few techniques used by farmers to deal with either a limited supply of water or excess supply. If the supply of water is limited, a farmer can bring additional water to the crop by irrigation or preserve the available water using conservation techniques. Excess water may be overcome using proper drainage techniques.

ACTIVITY 4

Alberta's Water-Resource Legislation

Because water is important to every Albertan, rules and regulations are needed to preserve this precious resource. The government of Alberta has enacted legislation to do just that. To understand the current laws regarding water, you must look back at Alberta's history of water-management legislation.

ALBERTA PUBLIC AFFAIRS BUREAU

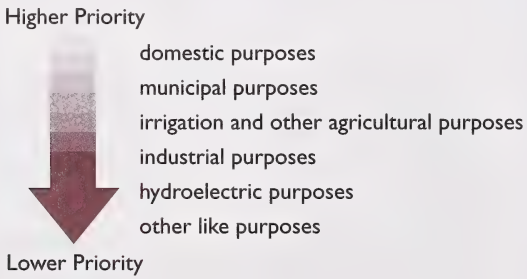
In 1894, the federal government passed the Northwest Irrigation Act to promote irrigation development. The underlying meaning of the act gave the government ownership of all water, and it gave the government the right to distribute water by issuing licences.

In 1930, Canada transferred the rights to all natural resources to the provinces. To recognize this transfer of rights, Alberta passed the Water Resources Act in 1931. This act included much of the federal government's original Northwest Irrigation Act.

Since 1931, the demand for water resources has changed. However, the Water Resources Act remained essentially unchanged from its 1931 state. It still allocated water until all supplies were exhausted. Since only a limited supply of water exists, the Alberta government passed the new Water Act in 1996. The new act changed the focus of water legislation from allocation to conservation and management.

How is water allocated now? The ownership of all surface and ground water belongs to the province. The provincial government grants a licence to each water user. A water licence specifies the quantity of water that a licence holder can draw from surface reserves or ground-water aquifers. Licences are granted without a specific expiration date and are not usually transferable from one party to another.

The priority given to licencees is on a first-come-first-served basis. If two applications are received on the same day for water from a common source, the government decides who has the priority on the following basis in descending order:



As the demand for water increases, so do the issues and disputes surrounding water use. Agriculture, industry, recreation, wildlife, and urban residents all want a secure supply of abundant, high-quality water.

If you are interested in learning more about water policies and legislation in Canada, you can contact the Environment Canada office closest to you or visit their Internet site at

http://www.ec.gc.ca/water/

Note that this address is subject to change.

Ethics

1. Why is it important for governments to put restrictions on water usage?
2. What was the purpose of the first water legislation enacted by the federal government in 1894?
3. If two people applied for a water licence at the same time, for withdrawal of water from the same source, who would get first priority? One person is seeking a licence to draw water for industrial purposes, while the other wants to draw water for irrigation purposes.

Compare your answers with those in the Appendix, Section 1: Activity 4.

You should now have a better understanding of Alberta water legislation. As demand on the water resources increases, it is necessary for the government to continue to develop its legislation to meet the needs of Albertans now and in the future.

ACTIVITY 5

Effects of Agricultural Practices on Water Quality

Do you ever wonder about the quality of the water that comes out of your kitchen faucet? Many people do. Some have turned to drinking bottled water or filtering tap water before drinking it.

People's concerns about water quality are justified. Pollutants have been known to enter water sources. Take, for example, the case in India where an estimated 30 million people have been exposed to the toxic effects of arsenic.

Arsenic is a naturally occurring substance found in soils covering a large area of India. The toxic material washed into aquifers supplying water to farmers living in the region. The number of people who died from the poison is unknown, but at last count approximately 200 000 people showed symptoms of arsenic poisoning. Symptoms of arsenic poisoning include lesions on palms and soles of feet, skin cancers, and nerve disorders.

Arsenic poisoning in India came about through natural means, but water can be polluted by the activities of people too. Several agricultural practices have the potential to cause water pollution. In this activity you will look at the relationship between water quality and these agricultural practices: manure management, tillage, fertilizer application, and chemical weed control.

Manure Spreading

Waste management is a problem for farmers who raise large numbers of animals in a concentrated area. There are two common ways to collect animal wastes. One way is to wash it into pits. The other is to scrape it into piles. The problem comes in trying to dispose of the manure once it has been collected.

Improper disposal of animal wastes can have adverse effects on the ecology and human health. One problem associated with improper handling of animal wastes involves pollution of surface waters. Nitrates and phosphates leach out of the manure and concentrate in the surface waters. Nitrates and phosphates promote the growth of algae and other aquatic plants. With a large supply of nitrates and phosphates, aquatic plants flourish. When these plants die and decay, they give water an unpleasant taste and smell. In addition, bacteria that are active in the decay process use oxygen. If too much oxygen is used by the bacteria, fish living in the water will die.

Another problem associated with improper handling of manure involves pollution of drinking water. In large quantities, nitrates are hazardous to humans. They are very mobile and easily find their way into drinking water supplies. Health problems associated with nitrates include stomach cancer and blue baby syndrome (methaemoglobinaemia).

1. What two hazards are associated with improper handling of animal wastes?

Compare your answer with the one in the Appendix, Section 1: Activity 5.

One of the best ways to deal with stockpiles of animal waste is to spread it over farm fields. Manure enriches soils by adding nutrients and organic matter. It also improves the water-holding ability of soils. These traits aid in plant growth.

To reduce the possibility of water contamination, farmers must take care when spreading manure on fields. It should not be applied where it could be carried into surface waters. Manure should be worked into the soil as soon as possible. Working it into the soil places the nutrients in a proper position for plant growth and reduces the likelihood that nutrients will be lost. To avoid contaminating spring run-off waters, manure should be spread in spring, summer, or fall, but not in winter when the ground is frozen.

There are a couple of problems associated with spreading manure on fields. Manure can contain harmful elements like bacteria, salts, and live weed seeds. Manure also has an unpleasant odour.

Ethics

2. Describe how you would dispose of animal wastes.

Compare your answer with the one in the Appendix, Section 1: Activity 5.

Tillage

Tilling soil has several beneficial effects. It

- loosens the soil
- mixes air in the soil
- kills weeds
- creates ridges and pockets that trap water

These effects help crops grow. Loosening the soil makes it easy for young roots to make their way through the soil. Air in the soil allows plant roots to respire. Killing weeds reduces competition for nutrients, water, and sunshine. Trapping waters increases the soil's moisture reserves, which can be used by plants during the growing season.

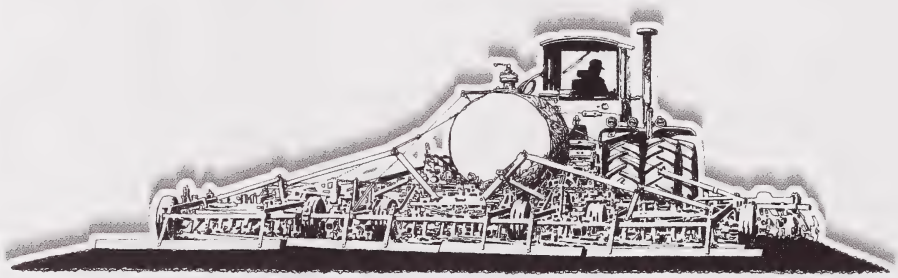
Too much tillage, however, can be detrimental. Tillage costs money for fuel and equipment. Tillage turns the surface layer of soil, which causes it to dry out. Too much tillage can pulverize soil to the point where it is too loose. If the soil becomes too loose, it is easily carried away by moving water or winds. Erosion not only causes problems where the soil is lost, it also causes problems where the soil ends up. Soil carried into rivers and lakes makes water cloudy. A heavy load of soil can make the water an unsuitable habitat for aquatic animals. In some cases, it can make the water unsuitable for drinking by land animals.

3. a. Name two advantages of tilling soil.
   b. Name two disadvantages of tilling soil.

Compare your answers with those in the Appendix, Section 1: Activity 5.

Fertilizer Application

Fertilizer application is a common practice on Alberta farms and on lawns and gardens in towns and cities. Fertilizers are applied to enhance plant growth and replenish nutrients lost to cropping. Applying fertilizer is a worthwhile process, but it can also cause problems, particularly if too much fertilizer is used or if the fertilizer is applied incorrectly.



Most fertilizers increase the amount of nitrates and phosphates in soils. These substances are potentially hazardous to the environment and human health in the same ways as animal waste.

Water pollution caused by fertilizers and manure can also have negative effects on water sports. Waters can become filled with algae and clogged with weed patches. It is unlikely, then, that these waters will be used for swimming, boating, or fishing. Thus, water pollution caused by runaway nutrients can curtail recreational use of waters. This can have negative effects on local economies by reducing the amount of tourism dollars spent by people who used the waters before they were polluted.

4. Why would tourists avoid lakes and rivers that had been polluted by excess fertilizers?

Compare your answer with the one in the Appendix, Section 1: Activity 5.

Using Agricultural Chemicals

Water can be polluted by agricultural chemicals. Farmers use powerful chemicals to kill weeds and insect pests. These chemicals are rigorously tested before they are used; however, a compound strong enough to kill a plant or an insect is undesirable in a water supply.

To reduce the possibility of water pollution, people must take certain precautions. Here are a few:

- Be very careful not to spill chemicals on the ground or into surface waters.
- Properly dispose of empty chemical containers to avoid pollution caused by tailings. In Alberta, special dumping areas are set aside for containers used for hazardous materials.
- To avoid contamination of waters adjacent to fields, spraying operations should take place on calm days. Farmers should use properly adjusted spraying equipment to ensure minimum drift.
- Use chemicals that lose their poisonous effects in the shortest period of time.
- Reduce usage of agricultural chemicals by controlling weeds and pests through tillage or biological controls. Biological control means introducing a living organism that destroys the harmful pests but does not affect the rest of the environment.

5. Proper management practices ensure water quality is not harmed when farmers complete certain activities. Suggest at least two management practices that may be used for applying agricultural chemicals.

Compare your answer with the one in the Appendix, Section 1: Activity 5.

You should now understand the effects agricultural practices can have on water quality and some ways that farmers can reduce the problems associated with those practices.

ACTIVITY 6

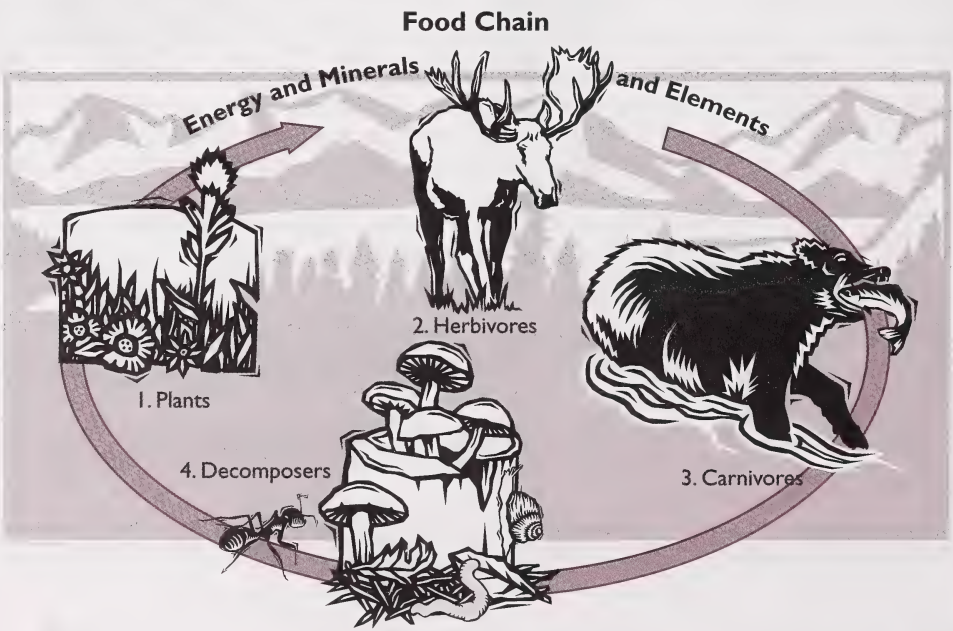
Impact of Water Supply on Life

Too little water, too much water, or contaminated water can seriously hamper plant growth. This can have a major effect on other life forms since all life depends on the ability of plants to convert and store the sun's energy. The process of converting the sun's energy into useable plant energy is called photosynthesis.

Photosynthesis

Photosynthesis is a process in which plants convert water, carbon dioxide, and the sun's energy into plant foods. It takes place in chloroplasts. Chloroplasts are little green bodies found in plant leaf and stem cells.

Chloroplasts produce glucose, which is a simple sugar. Glucose is the building material used to produce over 94% of a plant's dry weight. Some of the glucose is made into plant tissues and some goes into making starches and more complex sugars.



Herbivores, such as deer, rely on plant materials for food. Carnivores, such as wolves, rely on herbivorous animals for food. When carnivores die, their bodies decompose into minerals and elements that become food for plants. This completes the circle of a food chain.

People fit into a more complex food chain, because they eat both plants and animals. However, since plants are consumed by the animals people eat, plants are the first link in people's food chain, too.

A large amount of water is needed to complete a food chain. It has been estimated that over 17 000 L of water are needed to produce three meals a day for one person. Just think how many litres it would take to feed the people in your community on any given day. It's a staggering amount, isn't it?

Water is part of the photosynthesis process, and the food chain shows that photosynthesis is equally important to plants, animals, and humans. Anything that impedes the photosynthesis process endangers all life on Earth. Therefore, it is very important to protect Earth's water supplies.

The water for photosynthesis comes from the soil. Plants draw water from the soil through their root systems. Too little water or too much water in the root zone has the same effect—it stops photosynthesis. Too little water means plants can't get the water they need for photosynthesis. Too much water causes plant roots to drown and therefore cuts off water to other plant parts.

Other things can impede the photosynthesis process. Poisons, for example, can damage leaves, stems, or roots. High salt content in the soil can prevent plants from obtaining water.

Other Life Processes

Although photosynthesis could be considered the most important process, there are others that are necessary for life. Water plays an important role in those processes as well. For example, plants obtain necessary minerals like phosphorus and sulphur through their root systems in water solutions. Plants also use water to cool themselves during the transpiration process.

Like plants, animals need water in order to live. Water plays an important role in supplying them with food. Over 95% of the water needed to produce meat from livestock is actually used for growing plants for their feed. It has been estimated that it takes 4000 L of water to grow alfalfa and other forage crops used by an animal to produce a single kilogram of beef.

Farm animals also need a considerable amount of water for direct consumption. The following chart gives you some idea of how much water is required for animals to live each day. Animals use water for bodily functions like perspiration and waste excretion.

Major Categories of Livestock and Their Respective Daily Water Use	
Livestock	**Water Use Litres/Day/Head**
Milk Cows	154
Bulls	97
Horses	68
Steers	51
Calves	25
Pigs	6
Sheep	4
Other Poultry	0.5
Hens and Chicken	0.3

[1]

1. A farming operation has the following:

   - 50 milk cows
   - 2 bulls
   - 14 steers
   - 200 pigs
   - 75 chickens

   Use the chart to calculate how much water these animal would need on a given day.

2. If an area suffered a prolonged drought (time with little or no precipitation), what problems would be faced by the following:

   a. crops
   b. animals
   c. humans

3. Describe the importance of water to life on Earth.

Compare your answers with those in the Appendix, Section 1: Activity 6.

In this activity you examined the impact water supply has on life. Food production is directly affected by the availability of water. Plants, the basis of the food chain, need water for photosynthesis, nutrient absorption, and transpiration to produce adequate yields. How well plants do affects how well animals and humans do, because they are dependent on plants for sustenance.

Agriculture operations must be carefully managed to ensure the water resources are protected. This requires planning and management strategies that recognize the potential dangers and provide realistic solutions.

[1] Society, Environment and Energy Development Studies Foundation, *Water and Agriculture: Student Book* (Edmonton: Alberta Environmental Protection, March 1995), 13. Reprinted by permission.

FOLLOW-UP ACTIVITIES

If you had difficulties understanding the concepts in the activities, it is recommended that you do the Extra Help. If you have a clear understanding of the concepts, it is recommended that you do the Enrichment.

Extra Help

Water is a vital resource in Alberta. To protect this resource, water-management strategies must be used. The following case study illustrates how water resources can be managed. Read the case study to review the concepts of water-resource management; then answer the questions that follow it.

Case Study

RYCROFT SIGNAL

Hans Terlson is planning to set up a hog operation 5 km from the Peace River in northern Alberta. Although he has thoroughly researched the proposed hog operation, he still has some concerns about the effects it may have on the environment.

He is concerned that waste from the hog barns will find its way into surface- and ground-water supplies. Hans takes his concerns to local agrologist Kala Boutin.

Kala considers the issues carefully and replies, "Hans, your concerns are valid. The potential impact of intensive livestock operations on water quality is an important issue. Improper disposal of livestock manure can seriously affect both surface- and ground-water supplies."

Kala goes on to say how improper storage of manure causes problems. Manure can contain high levels of bacteria, salt, and nitrates, all of which are potentially harmful to plants and animals. If manure is picked up by surface run-off, it can be carried into lakes, rivers, streams, ponds, and ditches.

Some of the run-off can move down through the soil into ground waters. Contamination of ground-water supplies is very serious because it is next to impossible to clean an aquifer once it has been tainted.

Large quantities of waste products entering the Peace River would be undesirable because they would reduce the water quality for people and animals downstream. Water quality could be so seriously damaged as to make water from the river undrinkable by humans or animals.

Nitrogen in the manure would encourage aquatic plant growth. If left unchecked, the aquatic plants would continue to grow to the point where they would choke the river system. Living and decaying water plants would use up oxygen needed by fish and other aquatic organisms. Decaying plant material would cause the water to take on unpleasant tastes and odours. These conditions would reduce the desirability of the river as a source of recreation.

Hans asks Kala if anything can be done to protect the existing water resources.

Kala replies, "This may sound like a problem with no solution, but with careful management there is a workable solution." She then explains that a properly constructed waste lagoon would reduce the risks.

Kala recommends that Hans construct a pit to collect and store liquid manure. She gives Hans a copy of the design specifications set out by the provincial government for such a lagoon. The lagoon should be dug into the soil. The sides of the pit should be made of hard-packed clay approximately 50–100 cm thick. The clay acts as an impenetrable barrier to keep contaminants within the lagoon.

Kala explains that the lagoon must meet the provincial government's standards and that it will be inspected after it has been constructed. If it passes the inspection, it can be used to collect waste from the hog barns.

Kala goes on to say, "You can then use the liquid manure as fertilizer on your fields. Be sure to spread it out on your land. Don't apply too much in one spot or you run the risk of undoing all your precautions to avoid water pollution. Work the manure into your soil immediately after you apply it. That way you won't lose nutrients."

"I won't lose friends and neighbours, either," chuckled Hans.

1. What concerns did Hans have concerning his hog operation and its effects on the surrounding water sources?

2. What are some of the potentially harmful elements found in manure?

3. Why is it especially serious to contaminate ground-water supplies?

4. What negative effects of animal waste entering the Peace River did Kala identify?

5. What did Kala propose to reduce the water pollution risks posed by Hans' hog farm?

Compare your answers with those in the Appendix, Section 1: Extra Help.

Enrichment

Water conservation to support plant and animal life is an issue in rural settings, but is it also an issue in urban settings? The answer to this question is yes. In general, most urban centres have enough water for consumption, watering lawns and gardens, and industrial uses. This water resource costs money to the people who use it and to the town or city that provides it. Water conservation in urban settings becomes even more of an issue during a prolonged dry period.

1. How can people in urban centres conserve water?

2. What advantages do you see in practising water conservation in an urban setting?

Compare your answers with those in the Appendix, Section 1: Enrichment.

CONCLUSION

After completing this section, you should have a better understanding of what water resources exist in Alberta and what makes water suitable for agricultural use. You explored what is being done by the government to protect the resource, as well as what people can do to preserve water quality. You examined the effects agricultural practices have on water quality and the impact that the water supply has on life. You should now be able to tie all aspects of water management together by reviewing a specific strategy for water management in a rural area.

Water is an important resource to agriculture. Because agriculture plays a key role in providing the essentials of life, the management of water resources is very important. A supply of water is needed and the supply must be useable.

Water is needed for more than just agriculture; it's an important resource for all lifeforms. Fish, for example, need water to exist. They, too, need more than just a supply of water. The water they need must also be useable. So, if you have an aquarium with fish, you are a water-resource manager.

ASSIGNMENT

Turn to your Assignment Booklet and do the assignment for Section 1.

Soil Management

IMAGINE that this orange is Earth. Remove three-quarters of the skin—this represents the amount of land covered by seas. Now, peel off half of the remaining skin to represent the amount of land covered by bogs, deserts, mountains, polar icecaps, and cities. Finally, peel off three-quarters of the remaining skin to represent the land that is too cold, too wet, or too rocky to be useable.

What remains is 1/32 of the peeling. This represents the amount of land that can be used for agricultural purposes. From this land, people raise the plants and animals they need to survive. Because people rely so heavily on the land for survival, they must manage its thin layer of soil carefully.

In this section you will look at how soils are managed. Before you do that, though, you will look at soil composition, how soils are formed, and how they are classified. Then you will study different soil-management techniques.

SECTION 2

ACTIVITY 1

Soil Composition

Take a few minutes to come up with your own definition of soil. Did any of these statements show up in your definition?

- Soil is dirt.
- It is brown.
- Plants grow in it.
- Buildings are constructed on it.
- When it is wet, it sticks to your shoes and it gets your clothes dirty.
- Soil is a relatively thin layer of loosely held materials covering Earth's surface.
- It is made of minerals, organic matter, air, water, and living organisms.

Your definition should include part or all of the last two statements. They describe soil in fairly technical terms. In this activity you will add to your knowledge of soils by examining soil ingredients, starting with minerals.

▼

crystalline: *composed of molecules arranged in a definite repeating internal structure; crystal-like*

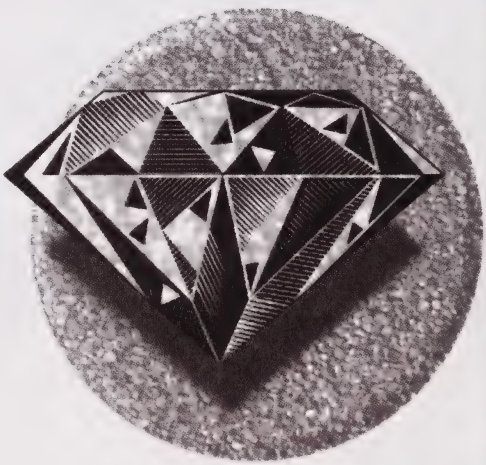
inorganic: *not of plant or animal origin*

elements: *smallest units of matter retaining individual characteristics*

▲

Minerals

What Are Minerals?



Minerals are solid, **crystalline**, naturally occurring, **inorganic** substances. Most minerals are made of two or more **elements**. There are a few minerals that are made of one type of element like gold (Au) and diamond (C), but such minerals are rare.

▼
lustre: *shiny surface*
▲

Each mineral is recognized by certain characteristics such as colour, hardness, shape, and **lustre**. That is because the composition and internal structure of each mineral is different. Here are a few of the most common minerals found in Alberta's soils.

Minerals in Alberta Soils

Mineral Name: Chemical Formula	Characteristics
Orthoclase: $KAlSi_3O_8$	• white, pink, or salmon coloured • found in granite rock
Plagioclase: a mix of $CaAl_2Si_2O_8$ and $NaAlSi_3O_8$	• white, light to dark grey with no streaks • found in granite rock
Hornblende: $(XSi_8O_{22})(OH)_2$, where X=Ca, Na, Mg, Fe, or Al	• dark green to black • usually forms in long, thin crystals
Muscovite: $K(Al_2)(AlSi_3O_{10})(OH)_2$	• white or transparent
Biotite: $K(X)(AlSi_3O_{10})(OH)_2$, where X=Mg, Fe, or Al	• black or dark brown
Quartz: SiO_2	• usually clear or white, but it can be any colour
Clay minerals: XSi_4O_{10}, where X =Al, Mg, Fe, Ca, Na, or K	• microscopic with earthy lustre
Calcite: $CaCO_3$	• usually white, grey, or colourless • bubbles in weak acid

Quartz is the most abundant mineral on Earth. Its chemical formula, SiO_2, signifies the smallest unit of quartz has one silicon atom surrounded by two oxygen atoms.

1. What is a mineral?

Compare your answer with the one in the Appendix, Section 2: Activity 1.

Where Do Minerals Come From?

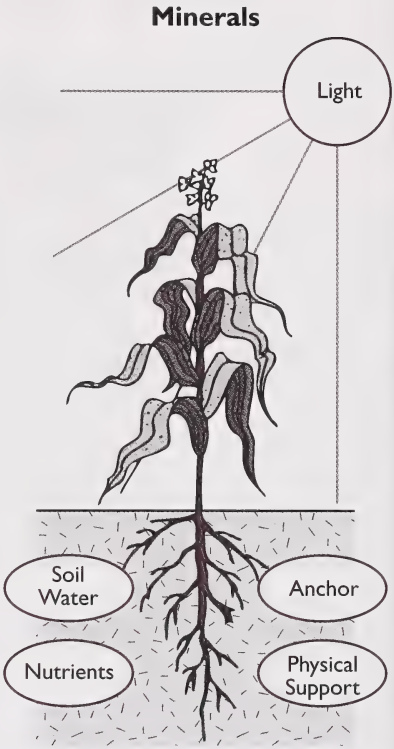
▼
unconsolidated: *loose, unattached*
▲

Soil minerals come from rocks. Evidence suggests that at one time Earth's surface was covered only with solid rock and seas. Over time, the rock surface was scuffed, resulting in a thin layer of **unconsolidated** mineral material, which formed the base for present-day soils.

What Do Minerals Do to Help Plants Grow?

The mineral portion of soil helps growing plants in the following ways:

- It supplies plants with essential nutrients like calcium (Ca), potassium (K), phosphorus (P), and sulphur (S).
- It physically supports plants.
- It anchors plants in one place.
- It protects plant roots from the sun's drying rays.



2. Where do minerals come from?
3. Name four ways that minerals help plants grow.

Compare your answers with those in the Appendix, Section 2: Activity 1.

Organic Matter

What Is Organic Matter and Where Does It Come From?

▼
feces: *bodily wastes*
▲

Organic matter is solid plant or animal material in various stages of decomposition. It is usually dark brown in colour. Dead leaves, stems, and roots are examples of plant organic matter. Animal **feces** and carcasses are examples of animal organic matter.

▼
lignin: *organic hardening agent found in wood cell walls*
▲

Organic matter is a storehouse of plant food because it contains materials absorbed and used by previously living things. At the early stages of decomposition, organic matter contains sugars, fats, proteins, cellulose, **lignin**, and minerals like phosphorus.

Most of the material in organic matter is not immediately available to plants. It must be broken down into simpler compounds. This is done by decomposers like insects, worms, fungi, and bacteria. Decomposers consume the rotting organic matter. They either excrete materials that are useful to plants, or they die and their bodies are broken down into useful plant materials.

Organic matter adds to soils in other ways. Have you ever had pine pitch on your hands? It was like glue, wasn't it? Organic matter tends to act like pine pitch. It binds mineral particles together. This helps prevent soil particles from being picked up by wind or washed away by water. It also creates larger soil units, which in turn create spaces between soil solids. This allows more air and water to enter the soil.

Another favourable characteristic is that organic matter acts like a sponge. It absorbs and holds water.

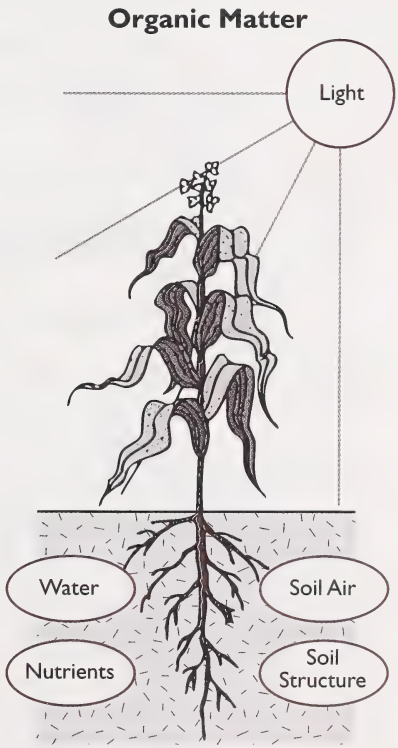
4. What is organic matter?

Compare your answer with the one in the Appendix, Section 2: Activity 1.

What Does Organic Matter Do to Help Plants Grow?

Here is a summary of what organic matter does to help plants grow:

- It is a storehouse of plant nutrients.
- It binds mineral particles together, saving them from being eroded and thus retaining mineral nutrients.
- In binding mineral particles together, it creates larger spaces between solids making it easier for water and air to enter the soil. Both substances are essential for plant growth.
- It creates large cracks, which helps freshen soil air. Large openings make it easier for stale air containing high proportions of carbon dioxide to be replaced by new air containing more oxygen.
- It acts as a sponge, collecting and holding water that plants can access.



5. Name four ways that organic matter helps plants grow.

Compare your answer with the one in the Appendix, Section 2: Activity 1.

Air

What Is Air and Where Does It Come From?

Air is a mixture of gases and solids in Earth's atmosphere. It moves into spaces and gaps between soil solids. Dry, clean air is composed of 78% nitrogen gas and 21% oxygen gas. The remaining 1% is mostly argon gas with tiny amounts of other gases such as carbon dioxide.

The air you breathe has varying amounts of moisture in it. The amount of moisture depends on the temperature of the air and how close it is to a water source. Warm air tends to have a higher moisture content than cool air. Likewise, air over a water body tends to have a higher moisture content than air over a dry spot.

The amount of dust particles in the air depends on the activities going on in an area. For example, in Alberta there is more dust in the air during fall harvesting. You may have noticed that sunsets are more spectacular at that time of year. The red skies are largely due to the sun shining on dust particles in the air.

Soil air may have more or less of each item mentioned depending on what is happening in the soil. For instance, if the soil is thick with plant roots, the soil air may have a lower proportion of oxygen and a higher proportion of carbon dioxide, because plant roots breathe much like you do. They draw oxygen from the air and expel carbon dioxide.

6. What is air composed of?

Compare your answer with the one in the Appendix, Section 2: Activity 1.

What Does Air Do to Help Plants Grow?

amino acids: *organic acids containing NH_3*

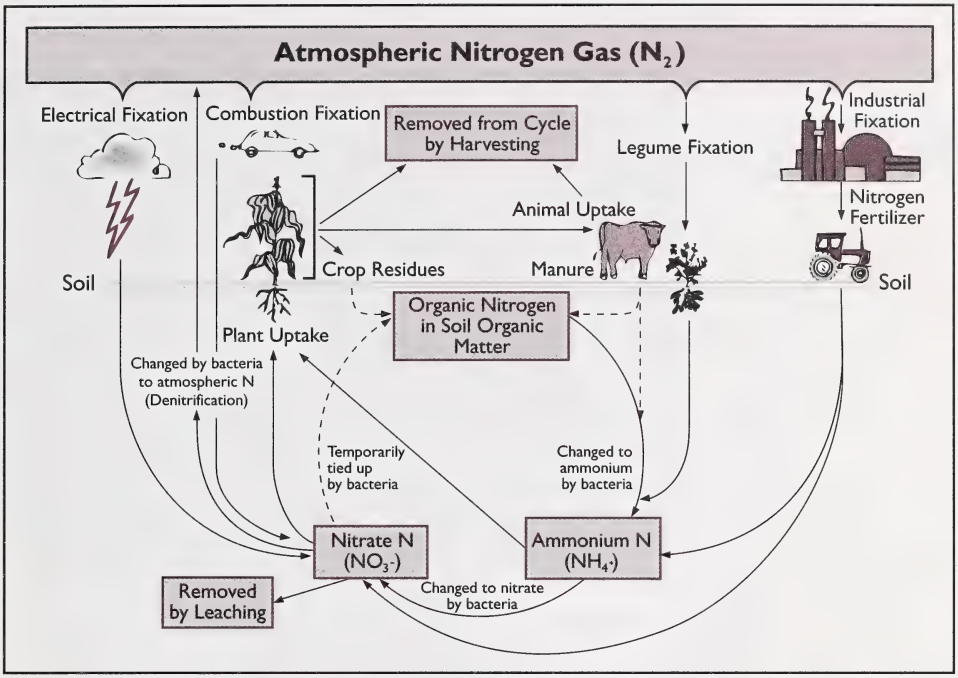
nitrate: *salt or acid containing NO_3*

ammonium: *a charged particle containing one nitrogen atom and four hydrogen atoms; NH_4^+*

Plants are able to respire because air contains oxygen. Air also contains nitrogen, another vital element. Plants use nitrogen to produce **amino acids**, which are the building blocks for larger molecules like proteins and genes (DNA).

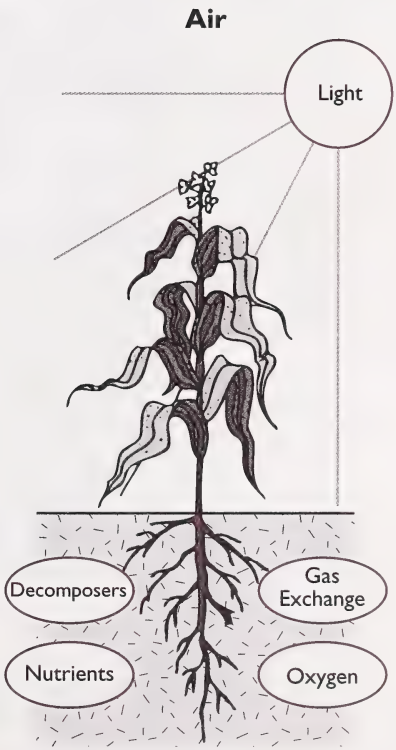
The problem is that plants cannot absorb nitrogen gas (N_2) directly from the air. To be useful to plants, nitrogen must be in a form such as **nitrate** or **ammonium**. In addition, these substances must be dissolved in water. Once the nitrogen compounds are in solution, plants can absorb them through their root systems.

Most of the nitrogen used by plants comes from the breakdown of organic matter. Some nitrogen, however, is taken from the air and converted by bacteria to a form that plants can use. Nitrogen goes through cycles or stages much like water does. Here is what the nitrogen cycle might look like.



In summary, soil air helps plants grow by

- providing plant roots with oxygen
- providing plants with a way to rid themselves of gaseous waste products like excess carbon dioxide
- providing decomposers with oxygen so they can produce plant nutrients
- providing bacteria with a source of nitrogen so they can produce nitrates or ammonium, which can be taken up by plants



Water

What Is Water?

Water is a liquid composed of two elements: hydrogen and oxygen. It has the chemical formula H_2O, meaning a molecule of water has two hydrogen atoms and one oxygen atom. The molecule is arranged so the two hydrogen atoms are closer together at one end. This gives the molecule a slightly polar electrical dynamic. It has a slightly negative charge at the oxygen end and a slightly positive charge at the hydrogen end. This arrangement gives water some special properties that make it one of the most important substances on Earth.

Properties of Water

Overall, water is a neutral substance because the hydrogen ends of a water molecule are attracted to the oxygen ends of other water molecules and vice versa. This makes water molecules stick together and gives water its fluid nature. It also makes it relatively inert; that is, it does not readily combine or react with other substances.

That isn't to say water does not interact with other substances. In fact, its slightly polar nature tends to split less-tightly-bound substances into smaller components. Because water molecules are strongly tied to each other, they are able to carry these components in solution. This makes it a very good **solvent**.

▼
solvent: *substance that can dissolve or form a solution with other substances*
▲

Water can be a cooling agent or a heating agent depending on the circumstances. It can be used to cool things because water is able to absorb large amounts of heat energy. In addition, it is fairly efficient at conducting heat energy away from the source. Conversely, heat energy that has been stored in water can be released, warming the surroundings.

7. Name three ways that people use water to cool things.

8. Name one way that people use water to heat things.

Compare your answers with those in the Appendix, Section 2: Activity 1.

Water expands when it freezes and exerts a great deal of pressure when it does freeze. The force is large enough to split rocks and boulders. This helps create more unconsolidated mineral material.

Another attribute of water is that as it freezes, it gives off a small amount of energy. This trait has been exploited by fruit growers. If there is a chance of a light frost before fruit is ripe enough to pick, some fruit growers will spray their trees or bushes with water. As the water freezes, it gives off heat energy. In many cases, the energy given off is enough to save the crop from frost damage.

Another important trait of water is its strong resistance to compression. This trait makes it a useful structural component. Living cells contain a fluid that is mostly water. The internal pressure created by cell fluid keeps cells firm. If the cells lose fluid, they become limp. That is why some plants wilt when they are dry. Their cells deflate and the whole plant gets limp.

Another attribute of water is that it binds to soil solids. Soil particles pull water molecules to their surfaces much like Earth pulls you to its surface. However, in the case of water and soil particles, the attraction is based on electromagnetic attraction as well as mass differential. Just as gravity diminishes as you get further from Earth's surface, the pull exerted by soil particles lessens as water molecules get further from soil particles.

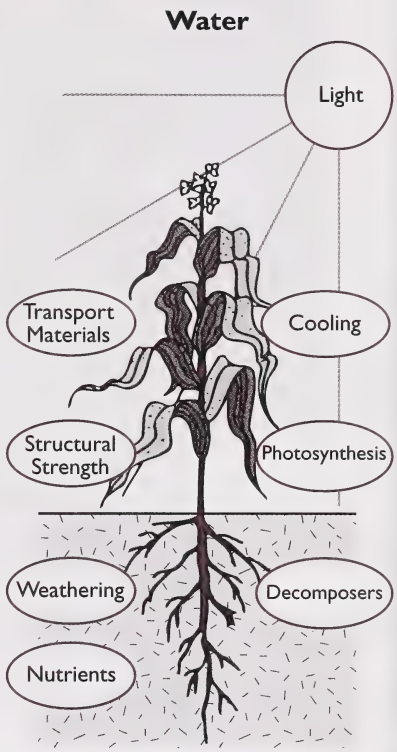
Where Does Soil Water Come From?

▼
percolate: *ooze or flow through*
▲

There are two ways water enters soil. It either comes from surface waters that move down into the soil or it comes from ground waters that **percolate** from below.

What Does Water Do to Help Plants Grow?

Here are a few of the things that water does to help plants grow.



- Water aids in the weathering of rock into unconsolidated mineral material, which is the base for soil.
- The only way plants can absorb a majority of the nutrients they require is if their roots are in a water solution.
- Some plants rely on water to provide them with structural strength. Their stems and other parts become firm when cells within them are filled with a fluid composed mainly of water.
- Plants take advantage of water's ability to absorb heat energy to cool themselves much like you do when you sweat.
- Plants use water to dissolve and carry wastes from their cells.
- Plants use water to dissolve and carry starches and sugars to and from living cells.
- Other living organisms that help plants grow, such as those that break down organic matter, need water to live.
- Plants use water in the photosynthesis process.

9. Name four ways that water helps plants grow.

Compare your answer with the one in the Appendix, Section 2: Activity 1.

Living Organisms

What Living Organisms Are Found in Soil?

Soil would not be soil without living organisms. If you examined a spade full of earth, you would likely see a worm and possibly a click beetle. If you looked closer at the soil using a magnifying glass, you might see some fungi. If you examined a sample of the soil under a microscope you would probably see colonies of bacteria.

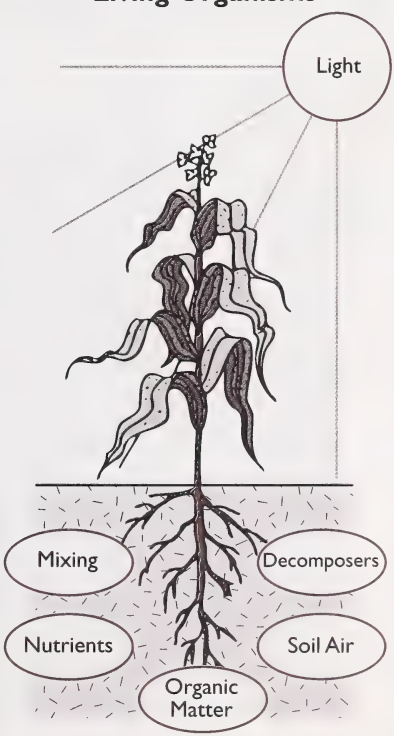
Larger animals also spend some time underground and their activities create cavities in soil and churn the soil material. Examples of burrowing animals include mice, gophers, moles, foxes, and badgers.

What Do Living Organisms Do to Help Plants Grow?

Here are a few of the things living organisms do to help plants grow.

- They assist in the decomposition of organic matter, converting it into components that plants can use.
- They defecate and their feces are incorporated into the soil.
- They die and their bodies are incorporated into the soil.
- They tunnel through soil making spaces for air and water to enter.
- They dig in the soil bringing new minerals to the surface.
- Certain bacteria are able to take nitrogen from the air and change it into a form that plants can use.

Living Organisms



10. Name four ways that living organisms help plants grow.

Compare your answer with the one in the Appendix, Section 2: Activity 1.

In this activity you studied the components of soil and how each contributes to plant growth. In the next activity you will explore how soils form.

ACTIVITY 2

Soil Formation

Soil-Forming Factors

There are five factors contributing to how soils form:

- parent material
- climate
- vegetation
- topography
- time

Type of Parent Material

▼

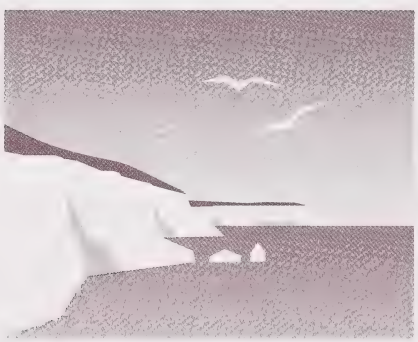
till: *hard-packed clay containing sand, rocks, and boulders*

bedrock: *underlying consolidated rock*

▲

Parent material is the original mineral material from which soils form. When it comes to mineral soils, a big factor in the type of soil formed is the type of parent material in the area. Most of Alberta's soils have glacial **till** as their parent material.

During the last ice age, which started about 35 000 years ago, glaciers moved over much of North America. Ice sheets, at times 1600 m thick, flowed over the **bedrock** gouging out pieces of rock.



Waves of loose mineral material were pushed in front of the ice. This loose material was smoothed and worn as it tumbled along. Pieces of rock caught under the ice were ground into fine powder.

About 12 000 years ago, the glaciers receded. As they receded, they left behind tonnes of loose mineral material. If you sorted this unconsolidated material, you would find it comes in various sizes. The following chart gives the names and sizes of particles found in glacial till.

Mineral Particle Sizes in Glacial Till	
Particle Name	**Diameter of Particle (mm)**
Clay	< 0.004
Silt	0.004 to 0.062
Sand	0.062 to 2
Stones	2 to 64
Cobbles	64 to 256
Boulders	256 and larger

0 2 mm 10 mm 20 mm

shale: *sedimentary rock composed mainly of silt and clay*

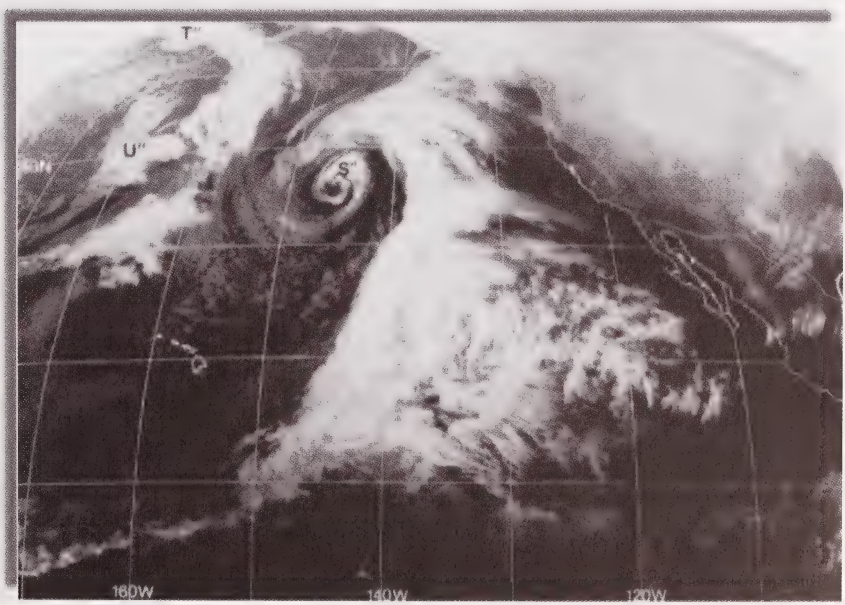
sandstone: *sedimentary rock composed mainly of sand*

Alberta's glacial till was gouged out of **shale** and **sandstone**. These bedrock materials are largely composed of clay, silt, and sand particles. Consequently, Alberta soils have a high proportion of clay, silt, and sand. Shale and sandstone also have a high calcium carbonate (lime) content; therefore, Alberta soils have a high calcium carbonate content.

1. Define glacial till by explaining what it is made of and how it is formed.

Compare your answer with the one in the Appendix, Section 2: Activity 2.

Climate



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Climate is a word used to describe the persistent weather patterns and cycles experienced at a location. Temperature, precipitation, and wind are the key elements of climate. They affect plant growth, mineral weathering, and decomposition rates.

Soil-Forming Elements of Climate

Temperature	Precipitation	Wind
• The milder the climate, the more vegetation grows and the more organic matter enters the soil. Extremes in temperatures, however, inhibit plant growth, resulting in less organic matter entering the soil; e.g., arctic conditions. • Extreme temperatures inhibit the decomposition of organic matter resulting in less plant nutrients in the soil and less movement of organic matter to lower levels in the soil. • Warm temperatures speed along chemical weathering of mineral materials. • Swings in temperature from one extreme to another increases physical weathering of mineral materials.	• In general, the more precipitation an area receives, the more vegetation grows there. The more vegetation that grows, the more organic matter is incorporated into the soil. However, extremes in precipitation levels inhibit plant growth; e.g., desert conditions. • Extremes in precipitation levels inhibit the decomposition of organic matter resulting in less plant nutrients in the soil and less movement of organic matter to lower levels in the soil. • The more precipitation an area receives, the more chemical and physical weathering of mineral materials takes place.	• Winds have a drying effect, which reduces plant growth and reduces the amount of organic matter going into the soil. • Dry conditions caused by wind result in less chemical weathering. • High winds have the potential to pick up soil particles and tumble them along, resulting in increased physical weathering of mineral materials.

Alberta's Climate

Alberta has a cool, temperate climate that has remained much the same for the past 4000 years. It has short, cool summers and long, cold winters. Some areas have slightly longer summers than other areas, and it is in these areas that nearly all agricultural activities take place. Most of these warmer areas are located in the southern half of the province, but there are areas in northern Alberta that are slightly warmer than others. The warmer areas in northern Alberta are usually found along the Peace River valley.

Precipitation rates vary slightly throughout the province. In general, it is drier in the southern and eastern regions than in the northern and western regions.

All areas of Alberta experience winds. However, wind plays a larger role in forming soils in southern Alberta. Grasses growing in southern Alberta allow air to move along the soil surface. In northern Alberta, trees push the wind up away from the soil surface.

Task Management

2. Based on the amount of precipitation and the information given in the Soil-Forming Elements of Climate chart, in which region in Alberta would you expect the most vegetation to be growing—west, east, north, south, or central regions?

3. Based on temperature and the information given in the Soil-Forming Elements of Climate chart, in which region would you expect to find the most chemical weathering of minerals?

Compare your answers with those in the Appendix, Section 2: Activity 2.

Vegetation

Vegetation affects how soils develop. The type of plants growing in an area determines how much organic matter is incorporated into the mineral base. In Alberta there are two main types of soils: forest soils and grassland soils.

Forest Soils

Forest soils have a thin, organic matter layer at the soil surface with some leaching of this material into the lower parts of the soil. They develop under forests, and forests grow where there is an abundance of precipitation.

There are two reasons why forest soils have a thin layer of organic matter near the soil surface. First, plants growing in soils containing abundant moisture usually have horizontally spreading root systems. Plant roots remain near the soil surface because they find sufficient water and nutrients there. That means that most of the organic material in a forest soil is concentrated in the top layer of the soil.

Another reason for organic matter being concentrated in the top layer of forest soils is that the dominant vegetation in forests is woody plants. Since wood is composed of substances that decompose slowly, much of the organic matter laid down on the soil surface remains intact for a long time. That is why you can visit a campsite year after year and sit on the same fallen log. It takes years for tree trunks to decompose.

Grassland Soils

Grassland soils have a different character. Like forest soils, they have a concentration of organic matter in the upper layer. However, there is much more organic matter incorporated in the lower regions of a grassland soil.

There is more organic matter in the lower regions of grassland soils because grasses grow in areas that experience dry periods. In order to obtain water during the dry periods, grasses produce long, fibrous root systems that extend deep into the soil. It is these deep root systems that are responsible for adding organic matter to the lower regions of grassland soils.

In Alberta, grasslands are found in the southern half of the province. Forests grow in the northern half. There is a transition zone in the middle where a mix of grasses and trees grow.

4. What is the difference between a grassland soil and a forest soil?

Compare your answer with the one in the Appendix, Section 2: Activity 2.

Topography

Topography is a soil factor that applies to smaller areas than the ones discussed previously. Topography of an area is its surface features: hills, rock outcroppings, depressions, streams, lakes, sloughs, or bogs. These features affect how soils form in a localized area. Take a large hill, for example. If you could look at a cross section of the hill, you would see a difference between the soil at the top of the hill and the soil at the bottom of it.

In most cases, soils on hilltops are less developed than soils at the bottoms of hills. The principal reason is that hilltops are drier. Water tends to drain off hilltops and collect at their bases. Since drier regions produce less vegetation, less organic material goes into soils on hilltops.

Another reason why soils on hilltops are less developed than soils at their bases is that hilltops are more susceptible to wind and water erosion. Wind and water often sweep materials from hilltops into valleys. This results in less organic matter going into soils on hilltops.

Land in Alberta has a variety of topographies.

Time

Time is the final soil-forming factor. It took about 10 000 years for the soil Alberta has now to develop. It took that long for the mineral base to be transformed into soils complete with organic material, soil water, soil air, and living organisms. The deepest soil in Alberta is about 50 cm deep. This means that under ideal conditions the rate at which soil is formed is 1 cm/200 years.

Summary of Soil-Forming Factors in Alberta

Factor	Alberta Situation	Description
parent material	glacial till	high proportion of clay, silt, sand, and calcium carbonate
climate	cool, temperate	• short, cool summers • long, cold winters • slightly warmer in southern half of the province and along the Peace River
vegetation	forest/grassland	• forests grow in northern half of the province and along western edge • grasslands grow in southern half of the province • mixed grasses and trees grow in a transition zone between grasslands and forests
topography	variable	local conditions vary from field to field
time	10 000 years	• has been about 10 000 years since the last ice age • ideal soil-forming rate 1 cm/200 years

ACTIVITY 3

Soil Classification

People use classification systems to organize their surroundings in meaningful ways. Organizing their surroundings gives them a better understanding of their environment and, in some cases, leads to better methods of doing things. Can you think of a classification system you used recently?

One you use daily is the classification or division of your residence into functional areas such as the bathroom, the living room, the bedroom, and the kitchen. Items are placed in each area based on their usage. For example, pots and pans are placed in the kitchen because that is where they are used. Classifying your house based on function makes sense because it saves you time and energy.

Classifying soils based on their characteristics makes sense, too. It organizes a great deal of information in a logical fashion and makes it possible to present that information in a meaningful way.

In order to classify soils, soil surveys are done. Soil scientists go out and examine soils, identify them, and plot their position on maps. Later, soils with similar characteristics are grouped. Since soils form as the result of wide-ranging factors, soil groups cover large areas. The end result is a map showing the different classes of soils. The Soil Group Map of Alberta can be found in the Maps in the Appendix. It shows where the nine soil groups are found in Alberta. You can get a Soil Group Map of Alberta by contacting Alberta Agriculture, Food and Rural Development.

PHOTO SEARCH LTD.

To determine whether a soil is a brunisol or chernozem, soil scientists dig into the soil and examine the soil layers. When they look at the soil layers, they are looking at the soil's **profile**.

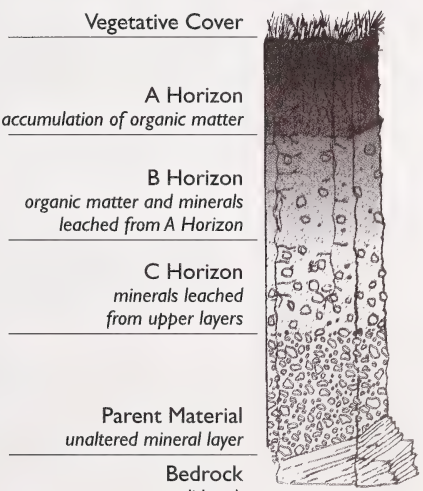
▼
profile: *side view*
▲

Soil Profiles

The layers in a soil profile are labelled A, B, and C, and they are called **horizons**. The top layer is the A horizon; under that is the B horizon; and under that is the C horizon. The thin layer of vegetation covering the A horizon and the parent material below the C horizon are not labelled.

▼
horizons:
horizontal layers of soil
▲

Soil Profile



leach: *dissolve out by the action of a percolating liquid*

The A horizon is usually the darkest layer in a soil profile because it contains the most organic matter. The B horizon becomes stained as materials **leach** into it from the A horizon. Organic matter makes the B horizon look darkest near the bottom of the A horizon and lightest near the top of the C horizon. The B horizon also becomes enriched with clay minerals, salts, and other materials that once resided in the A horizon.

Organic matter does not leach into the C horizon, so the C horizon remains the same colour as the underlying parent material. Salts and minerals do leach into a C horizon. In Alberta, what usually differentiates a C horizon from the parent material is an accumulation of calcium carbonate leached down from the upper layers.

The depth of each soil horizon depends on the soil-forming factors operating in the area. The A horizon will be deepest where the climate is best for plant growth. The depth of the B and C horizons depends on what is above them and how much water moves down through the soil.

1. How do soil scientists classify different soil types?

2. Which soil horizon is the darkest? Why?

Compare your answers with those in the Appendix, Section 2: Activity 3.

Soil Groups

Chernozemic Soils

parkland: *areas with a mix of grassy glades and trees*

Chernozemic soils are soils that formed under grasses or **parkland**. They have dark A horizons that are at least 10 cm thick. What distinguishes a black from a brown or dark-brown chernozemic soil is the depth and colour of the A horizon. Usually, black chernozemics have the thickest, darkest A horizons. Brown chernozemic soils have the thinnest, lightest-coloured A horizons.

The colour and thickness of the A horizon has implications for agriculture. The darker the soil, the more organic matter it contains. The more organic matter a soil contains, the better the soil is for plant growth. Remember, organic matter helps plants grow in several ways including providing a storehouse of plant nutrients, adding structure to the soil, and retaining water. That means black chernozemic soils are the best soils for growing crops.

Crops can be grown successfully on brown soils because they do have a storehouse of organic matter. However, brown soils are not as productive as black soils. What holds them back is a lack of precipitation. Brown soils develop in drier areas of the province.

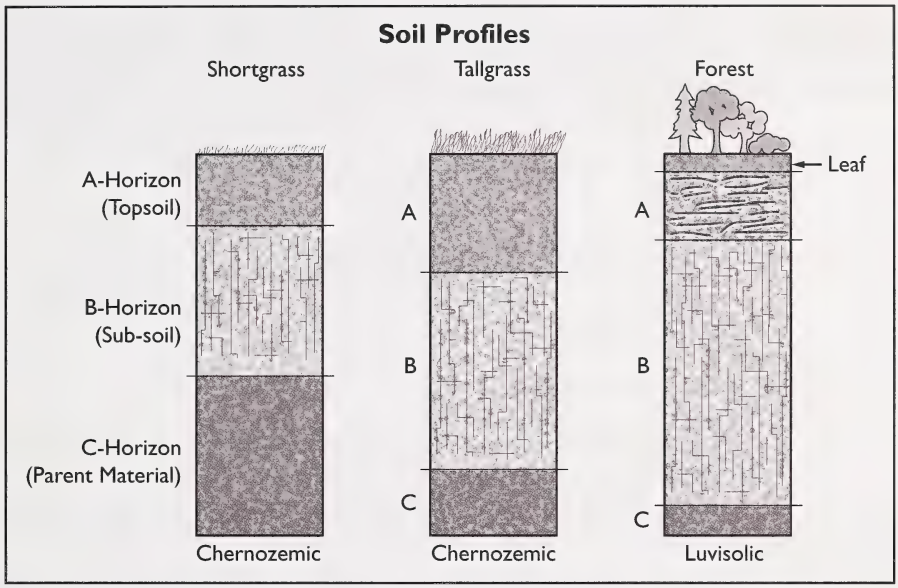
mixed wood: *areas where a mix of coniferous and deciduous trees grow*

Dark-grey chernozemic soils develop under parkland or **mixed wood** forests in the northern parts of the province. They have the characteristics of a chernozemic soil with a thick, dark A horizon. What makes them different from other chernozemic soils is that they show signs of materials leaching from the A to the B horizon as in a luvisolic soil.

3. What is the difference between a brown and a black chernozemic soil?

Compare your answer with the one in the Appendix, Section 2: Activity 3.

To get an idea of what a chernozemic soil and a luvisolic soil look like, examine the chart showing their profiles.



Luvisols

Luvisols develop under forests in the cooler regions of the province. They usually have thin, dark A layers and light-coloured, clay-enriched B horizons that are at least 5 cm thick. The presence of clay minerals makes the B horizon look flaky.

These soils can produce crops successfully depending on the climatic conditions. The most common production limitation on luvisolic soils is a short growing season.

Brunisols

Brunisols are forest soils, too, with thin, dark A horizons. What distinguishes them from luvisols is that their B horizons are not clay enriched like a luvisolic soil. They may be enriched in other minerals, which makes them look brownish or slightly reddish in colour. A reddish colour means there is iron present. Generally, brunisols are not used in Alberta for cropping.

Organic Soils

Organic soils form in water-logged depressions. These soils have a thick, organic A horizon that ranges in depth from 10 to 60 cm. To be classified as an organic soil, the A horizon must be composed of at least 30% organic matter by weight. Usually the underlying mineral layer is grey and full of clay.

Organic soils are not very good for growing crops. Although they have a huge amount of organic matter, they lack minerals necessary for good plant growth such as potassium, phosphorus, and sulphur. Another drawback is that the organic matter absorbs a large amount of water and retains it throughout most of the year. Overly moist conditions make the soil difficult to work and it encourages root rot and other plant diseases. Furthermore, the abundant organic layer acts like insulation, keeping the lower soil layers cool or even frozen long into the summer season.

Farmers have put these soils to use in several ways. The most economical use is pasture. However, some farmers have stripped off the organic layer and farmed the mineral layer below. Others have tried deep plowing to mix the organic layer with the mineral layer.

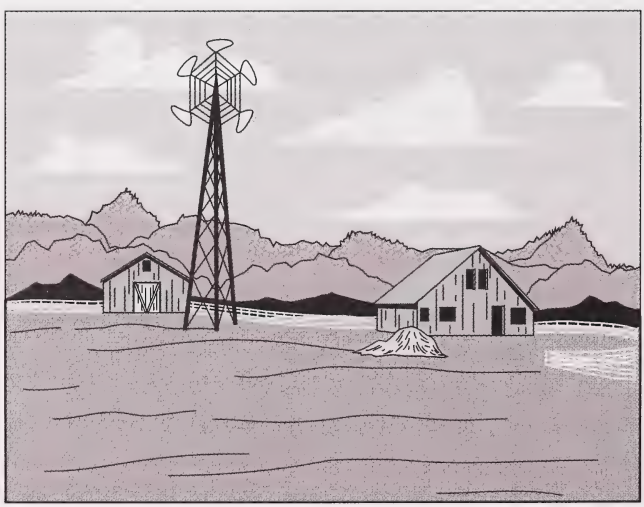
Cryosolic Soils

Cryosolic soils form under tundra areas and subarctic forests. They have permafrost within 2 m of the soil surface. Organic cryosols have a surface layer like an organic soil. Their cold temperature and lack of minerals makes them unsuitable for agricultural purposes.

4. Which soil group is the most productive for agricultural purposes? Why?

Compare your answer with the one in the Appendix, Section 2: Activity 3.

Now that you are aware of the different types of soil in Alberta, it is time to look at how to manage those soils.

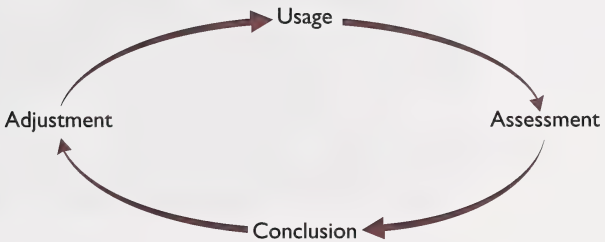


ACTIVITY 4

Soil-Management Techniques

Soil is a very important resource. It is the medium in which plants grow and plants supply the things people need to survive: food, clothing, and shelter. Because soil is very important, it has to be managed carefully. Good management is considered to be a cyclical process.

Management System



When talking about agricultural soils, usage is the growing of grains, vegetables, fruits, or forages. Assessment is done by looking for physical or chemical changes in the soil and suggesting plausible reasons for those changes. Conclusion is where reasonable responses are proposed for the changes observed. Adjustment is where the best responses are applied. The cycle repeats after that.

Much of a management cycle is devoted to observing what is happening to the resources, identifying negative side effects, determining the best possible actions in response to the observations, and implementing the recommended remedial actions.

Over the years, soil scientists have observed several negative effects caused by agricultural usage. Two of the most important ones are discussed in this activity.

Loss of Soil Nutrients

Soils are like bank accounts—they are both used to store something. Soils store plant nutrients, and bank accounts store money. Just as bank-account levels drop with each withdrawal, soil-nutrient levels drop with each crop grown. If nothing is put back into them, they reach critical points. Bank accounts drop to levels where the owners cannot purchase what they want because there isn't enough money. Soil-nutrient levels drop to where farmers have difficulty growing crops.

Farmers have been faced with the depletion of soil nutrients ever since farming began. Two methods farmers can use to deal with this problem include applying fertilizers and using summerfallow.

Applying Fertilizers

Animal Manure

Early farmers made the connection between cropping and reduced crop yields. One of their first attempts to remedy the problem was to spread manure on their fields. They must have observed that plants growing around dung piles grew better than other plants and concluded that all plants would grow better if they had access to some manure. They tested their theory and found it worked well, which made applying manure a common practice.

Some of the earliest writers refer to the use of manure to improve soils. Homer's epic poem *The Odyssey*, which was written somewhere between 900 B.C. and 700 B.C., mentions the manuring of vineyards.

Green Manure

Early farmers must have found that green manures were beneficial, too. Green manures are crops that are plowed into the soil before they mature. About 50 B.C., learned men, like the Roman poet Virgil, were promoting the use of green manures to improve soils. Virgil wrote that legumes were especially good as a green manure.

Compost

Compost is another organic fertilizer that goes back into antiquity. It is especially useful for gardeners to transform unwanted vegetable matter into a useful soil additive. Gardeners clear their gardens of stems, roots, and leaves after their crops have been harvested and place these materials in piles with alternating layers of soil. They encourage decomposers, like worms, insects, and bacteria, to work on the rotting vegetation by keeping the pile moist and stirring it once in a while.

It usually takes one or two years for the organic matter to break down into a dark, soil-like material. That material is rich in plant nutrients, so it has an immediate, positive effect on plant growth.

Today, composting can be done anywhere. In fact, most municipalities encourage their residents to compost vegetable matter like table scraps and lawn cuttings to cut down on the amount of garbage going into garbage dumps and landfill sites. Handling and processing garbage is becoming increasingly costly.

Chemical Fertilizers

Although farmers knew that organic manures and compost helped plants grow, they didn't know why. It wasn't until the late 1700s that people began to find out what nutrients were needed by plants and where they got them.

By the mid-1800s it became known that plants obtained essential nutrients like carbon, oxygen, and hydrogen from air and that they got water, nitrogen, phosphorus, potassium, and other mineral nutrients from the soil.

Scientists found that they could affect growing plants by changing the content of nutrients in their surroundings. For example, they found that plants died if carbon dioxide was removed from air. Conversely, they could promote plant growth by adding nitrogen to the soil. This information spawned the chemical-fertilizer industry.

Businesses began selling chemical fertilizers that contained essential soil nutrients.

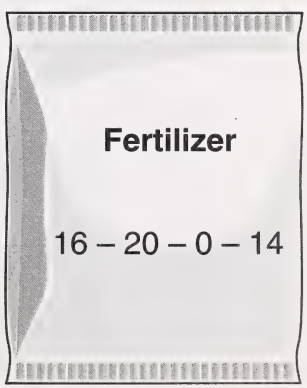
The nutrient content of a fertilizer is usually described by a series of numbers. For example, a fertilizer might have the following numbers: 16-20-0-14. Each number represents the percent of nutrient found in the fertilizer:

- The first number stands for the percentage of nitrogen (16%).
- The second number stands for the percentage of phosphate (20%).
- The third number stands for the percentage of potash (0%).
- The fourth number stands for the percentage of sulphur (14%).

The remaining 50% is composed of other elements associated with the nutrients. Therefore, if you had 100 kg of 16-20-0-14 fertilizer, you would have

16 kg of nitrogen, N
20 kg of phosphate, P_2O_5
0 kg of potash, K_2O
14 kg of sulphur, S
50 kg of unidentified material

100 kg total mass



The best placement for fertilizers is in the root zone of young, growing plants. There are a number of ways farmers apply fertilizer in order to get it in that zone:

- Broadcast – Solids are spread over the surface of the soil and then worked into the soil later.
- Sideband – Fertilizers are laid in a strip slightly below and to the side of where seeds are planted.
- With seed – Small pellets of fertilizer are placed along with seeds.
- Top dressed or side dressed – Fertilizer is broadcast over growing plants or beside them. The fertilizer is allowed to break down and seep into the soil.

1. Why are fertilizers applied to soils?
2. Name four types of fertilizer that are used in agriculture.
3. How much nitrogen would be found in 100 kg of a fertilizer with the numbers 21-11-0-0?

Compare your answers with those in the Appendix, Section 2: Activity 4.

The use of commercial fertilizers has greatly increased over the last three decades. Farmers today use more than six times the amount of fertilizer they did in 1965. Why this large increase?

The main reason for the increased use of fertilizer is to keep food production high. The population of the world is increasing, so there is increasing pressure to produce more food. Since there is a finite amount of arable land, it falls on producers to achieve more from the resources they have. Where 500 years ago farmers got one tonne per hectare of cereal, today's farmers get four tonnes. To obtain those results, farmers had to use chemical fertilizers to replace the soil nutrients lost to cropping.

Fertilizer Summary

This chart shows some of the pros and cons of each type of fertilizer.

Fertilizer Summary

	Organic Fertilizers			Commercial Fertilizers
	Plant Manure	Animal Manure	Compost	
Pros	• adds organic matter	• adds organic matter	• adds organic matter	• adds plant nutrients

	• adds plant nutrients • improves soil structure • increases available moisture • reduces acidity • restricts costs to seed, seeding, and plowing manure	• adds plant nutrients • improves soil structure • increases available moisture • reduces acidity • restricts costs to collecting, transporting, and applying manure	• adds plant nutrients • improves soil structure • increases available moisture • reduces acidity • has no cost as it uses unwanted materials	• has a known amount of nutrients in concentrated form • has nutrients immediately available to plants • are readily available to all farmers in commercial quantities
Cons	• unknown amount of nutrients present • most nutrients not available to plants until organic matter is decomposed • requires the skipping of one cropping season to grow the green manure	• unknown amount of nutrients present • smell • needs to be incorporated immediately after applied to fields to be most effective • may contain live weed seeds • may contain pathogens and parasites • not available to all farmers in amounts needed to replenish all nutrients used in cropping • most nutrients not available to plants until organic matter is decomposed	• unknown amount of nutrients present • most nutrients not available to plants until organic matter is decomposed • requires space for the pile • takes some care and attention to manage a compost pile successfully • not available to all farmers in amounts needed to replenish all nutrients used in cropping	• higher cost • contributes to soil acidity • usage may accelerate the breakdown of soil organic matter resulting in nutrient loss and compacted soils • requires large amounts of energy for production of nitrogen fertilizers

4. Name three advantages of using commercial fertilizers over organic fertilizers.

5. Name three advantages of using organic fertilizers over commercial fertilizers.

Compare your answers with those in the Appendix, Section 2: Activity 4.

Using Summerfallow

To summerfallow a field is to leave it uncropped for a season. It was considered to be a way of resting the soil that goes back many years. One of the laws given by Moses in the biblical book of Leviticus, which was composed about 1300 B.C., instructs Hebrew farmers to rest their land every seventh year.

There is some scientific proof that summerfallow does improve soil conditions, at least in the short term. It is attributed with building up the moisture content of soils, reducing the risk of disease transfer from one year to the next, reducing the population of insect pests, allowing for the mechanical control of weeds, and increasing the buildup of plant nutrients.

The last point has a downside. While the soil rests, decomposers continue to act on organic matter in the soil. Since little or no organic matter is added to the soil during the fallow period, there is a steady decrease in the amount of organic matter in the soil. As the soil loses organic matter, it loses many favourable attributes like structure and water-holding capacity.

Other problems caused by summerfallow are increased risk of soil erosion and salination. The risk of erosion is increased because without a plant covering, wind and water can act on soil particles, sweeping them off the field. The reduction in organic matter also increases the likelihood of soil erosion by reducing the materials that hold soil particles together.

Salinity is a problem in some areas and summerfallowing in those areas aggravates the problem. Summerfallow allows water that might have been used by plants to seep into the soil and percolate down into the parent material. In areas where salinity is a problem, the parent material is very salty.

Water dissolves salts and then makes its way back to the soil surface either because the soil becomes saturated or the water moves down an aquifer to a lower area where it seeps out. When the water evaporates, it leaves behind the salts. You may remember seeing places where this has happened. There is a tell-tale white crust at the bottom of dried-up ponds.

Salts interfere with plant growth. They hold onto water molecules very strongly. Most plants don't do well in saline soils because they can't get enough water. Therefore, salinity is something to be avoided.

There are ways to lessen the negative effects of summerfallow. One way is to refrain from tilling fallow fields. That way the residue from the previous crop stays on the surface. It protects the soil from wind and water erosion and absorbs water that might percolate down into the soil. Another thing that can be done is to grow a cover crop on the fallow field. Once a cover crop is in the leafy stage, it can protect the soil from wind and water erosion. Growing a cover crop is often chosen as an alternative to summerfallowing a field.

Summary of Summerfallow

Here is a summary of the pros and cons of using summerfallow to add nutrients to the soil.

	Summerfallowing
Pros	• increases soil-moisture content • reduces the risk of disease transfer from one year to the next • reduces the population of insect pests • allows for the mechanical control of weeds • increases the buildup of plant nutrients
Cons	• increases risk of wind and water erosion • reduces the amount of organic matter • increases soil salinity in some areas

6. Why would a farmer include summerfallowing as part of a soil-management system?

Compare your answer with the one in the Appendix, Section 2: Activity 4.

Soil Erosion

Soil erosion is a major problem. To a greater or lesser extent, it happens in all fields. Soil particles are moved along by the forces of wind and water. In some cases, the movement is small like from the top to the bottom of a small hill. In other cases, soil particles are completely removed from a field. Winds can pick up small soil particles and transport them for miles. Water can sweep soil particles into streams and rivers that carry them to distant seas.

Erosion reduces soil productivity by removing soil nutrients, organic matter, and beneficial organisms from a productive field. In extreme cases, water erosion can create deep gullies that make field work difficult or dangerous. The loss in soil productivity is estimated to cost millions of dollars each year.

Wind Erosion

The following factors affect wind erosion:

- Wind velocity – The greater the wind velocity, the more energy it has to lift and carry soil particles.
- Soil structure – The better the soil holds together, the less likely it will suffer from wind erosion. Remember, the greater the organic matter in the soil, the better its soil structure. Therefore, any practice that increases organic matter content of soil will help reduce wind erosion.
- Soil moisture – Wet soils are held together by their water content, so they are less susceptible to wind erosion.
- Plant covering – Any type of plant covering reduces wind erosion because the upper portions of the plants push the wind up and away from the soil surface and the roots hold the soil particles in place.
- Field size – The larger the field, the more area is open to wind erosion.

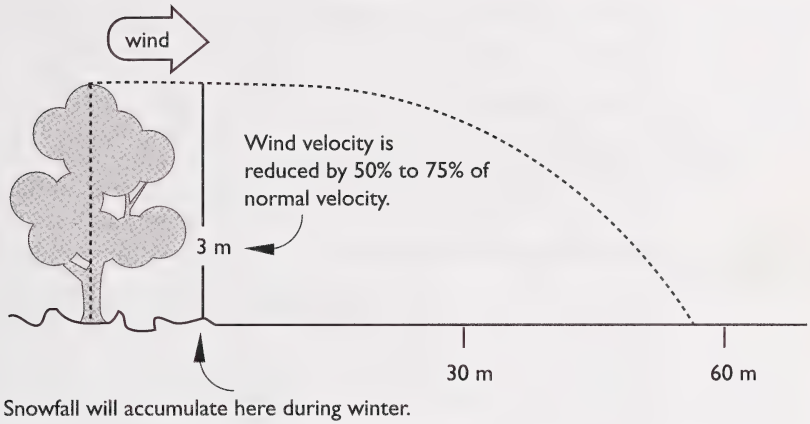
7. Name four factors that influence wind erosion.

Compare your answer with the one in the Appendix, Section 2: Activity 4.

Response to Wind Erosion

Shelterbelts

Shelterbelts are rows of trees planted in the path of prevailing winds. The object of a shelterbelt is to diffuse the force of the wind. A shelterbelt 3 m high will reduce wind velocity for 60 m on the lee side. Shelterbelts not only protect soil from wind erosion, they have a number of other beneficial qualities. They trap snow in winter, store moisture in summer, and provide a living area for wildlife. The windbreak also provides shelter for domestic animals from severe weather conditions.



Shelterbelts have a few negative aspects. Spreading trees in shelterbelts can interfere with field work. Shelterbelts can harbour weeds, plant diseases, and undesirable animals.

Shelterbelts also reduce the efficient use of large field implements. To be effective, shelterbelts have to be placed relatively close together. This creates small fields. Large machines turn awkwardly in small fields. They have to slow down, manoeuver the turn, and start up again. On some implements, pick-up reels have to be raised and lowered. This all takes time and energy.

Strip Cropping

Strip cropping means alternating summerfallowed areas between growing crops. The planted areas act to protect fallowed land from erosion. Soil particles that are eroded from the fallow area are caught and trapped by the plants in the planted area.

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A major difficulty with strip cropping is that erosion can take place before crops grow.

Cover Crops

Soils can be protected from wind erosion by maintaining a vegetative cover over fields. Plant roots hold soil in place while their stems slow down moving air. Cereals, annual grasses, or legumes are often used as plant coverings. Plants such as clover and legumes add nitrogen compounds to the soil.

Growing a cover crop not only helps prevent the immediate removal of soil particles, it has long-term effects. Cover crops are not harvested. They are plowed into the soil before maturity. Consequently, they add organic matter to the soil. Since organic matter adds to soil structure, this practice helps prevent soil erosion for many seasons. In fact, any practice that adds organic matter to the soil helps reduce erosion. That includes adding animal manure.

Problems associated with cover crops include the following.

- A field is taken out of production for a season.
- The cover crop uses available plant nutrients and soil water.
- It takes extra field work to plant and care for a cover crop.

Minimum or Zero Tillage (Zero Till)

Tillage means plowing, discing, or otherwise working the land. It is done in the spring to prepare the soil for seeding by breaking up the soil surface. In the fall, it is done to mix crop residues into the top layer of soil. Tillage is also used to kill weeds or incorporate fertilizers.

The practice exposes soil surfaces to wind and water erosion. Therefore, reducing the number of times soil is tilled reduces the risk of erosion.

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Zero till is a procedure in which the only time soil is disturbed is during seeding. A special seed drill is used to plant seeds into standing stubble and through crop residues left from the previous year. Since there is always some type of vegetative covering on zero-till fields, there is little chance of soil erosion occurring. An added bonus is that untilled lands retain moisture better than tilled lands. For that reason, zero till is a common practice in drier areas of the province and is generally associated with the brown chernozemic soils.

Zero till has a few drawbacks. One is that it requires special equipment, because it is harder to seed or fertilize untilled land. Another problem is that weeds have to be controlled with costly herbicides.

8. Choose one of the methods used to reduce wind erosion and discuss it in a paragraph. Identify the method and describe it. Then, explain how it helps reduce wind erosion.

Compare your answer with the one in the Appendix, Section 2: Activity 4.

Water Erosion

Soil structure, plant covering, and field size are factors affecting water erosion, just as they are factors in wind erosion. Soils with good soil structure resist water erosion better than other soils. Lush plant coverings hold soil particles in place so they are not swept away by water. Smaller fields reduce the amount of water that can collect into rills and streams and carry off soil particles.

Here are a few other factors that affect water erosion:

- Precipitation Rate – The amount of water erosion depends on the amount and speed with which water falls on an area. The more precipitation that falls and the faster it falls, the greater the risk of water erosion. A short, intense summer storm has more potential to do damage than a slow drizzle, even though the two weather conditions result in the same amount of precipitation.

- Field Slope – The steeper the grade of a piece of land, the greater the risk of water erosion.

- Soil Type – Different soils are more at risk of water erosion than others. Generally, coarse-textured soils are at less risk than fine-textured soils. Water moves easily into and through sandy soils leaving less water to move over the soil surface. Soils containing much fine-textured clay particles do not allow water to penetrate easily, which leaves water on the surface to puddle and stream away.

- Cultivation Practices – Cultivation leaves rows or furrows in fields. Water collects and moves along these furrows. If a field is plowed parallel with the slope, water will move along the furrow, picking up speed and force as it does so. The result is greater soil erosion.

Responses to Water Erosion

Many of the practices used to protect soils from wind erosion also work to protect soils against water erosion. Shelterbelts act to trap snow and block water movements. Strip cropping not only catches soil particles moved by wind, it also traps soil being moved by water. Cover crops prevent soil from being carried away by rain and melt waters. Zero till keeps a vegetative cover on soils all year round, which helps keep soil in place.

Here are a couple of practices that are specific to preventing water erosion.

Grassed Waterways

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Excess water will flow off land areas along natural channels. Cropping in these natural channels exposes the soil and actually promotes water erosion. Since water erosion can be so destructive, it makes sense to stabilize these areas.

One way to do that is to seed them with permanent grasses. Grasses fare well under moving water and rebound after being submersed for weeks on end. They are also good at trapping eroded soil material.

Grassed waterways do take land out of production. However, in most cases the cost of soil erosion is considerably more than the cost of a small swath of green grass in a field.

Contour Cultivation

Cultivation produces furrows and these furrows can lead to water erosion if they are parallel to the field slope. So, rather than cultivate straight up or down a slope, farmers can plow across the face of a hill. Furrows that run at right angles to the slope act like little dams. They hold back water from moving down-slope and in so doing help prevent soil erosion.

9. Choose one of the methods used to reduce water erosion and discuss it in a paragraph. Identify the method and describe it. Then, explain how it helps reduce water erosion.

Compare your answer with the one in the Appendix, Section 2: Activity 4.

If you are interested in learning more about soil erosion, you can contact the Alberta Agriculture, Food and Rural Development office closest to you and ask them for more information on the subject.

You could also search for information on the Internet under the words *soil erosion.* An Internet site where you will find information on soil erosion is Alberta Agriculture, Food and Rural Development at the following uniform resource locator (URL):

http://www.agric.gov.ab.ca/sustain/soil2.html

Note that this address is subject to change.

In summary, responses to erosion include the following:

- shelterbelts
- strip cropping
- cover crops
- adding organic matter to soil
- minimum or zero till
- grassed waterways
- contour cultivation

Soil is an important resource. It is the medium used to grow plants that supply basic needs like food, clothing and shelter. Like other valuable resources, soil needs to be carefully managed. Part of the management process is to identify problems. Two major negative effects agriculture has had on soils are loss of soil nutrients and erosion. Several responses have been tried to remedy these problems. A number of them were discussed in this activity.

After studying this activity, you should be able to discuss one of the problems identified. In addition, you should be able to offer three responses and discuss why those responses help the situation.

FOLLOW-UP ACTIVITIES

If you had difficulties understanding the concepts in the activities, it is recommended that you do the Extra Help. If you have a clear understanding of the concepts, it is recommended that you do the Enrichment.

Extra Help

Soil is composed of minerals, organic matter, air, water, and living organisms. Each component helps plants grow in several ways.

1. To help you better understand what each component does, match the soil component with the statements that apply to it.

   - minerals
   - organic matter
   - air
   - water
   - living organisms

   a. Certain bacteria are able to take nitrogen from the air and change it into a form that plants can use.

   b. In binding mineral particles together, it creates larger spaces between solids making it easier for water and air to enter the soil.

   c. They assist in the decomposition of organic matter, converting it into components that plants can use.

   d. It anchors plants in one place.

   e. It is a storehouse of plant nutrients.

f. It supplies plants with essential nutrients like calcium (Ca), potassium (K), phosphorus (P), and sulphur (S).

g. Plants use it to dissolve and carry starches and sugars to and from living cells.

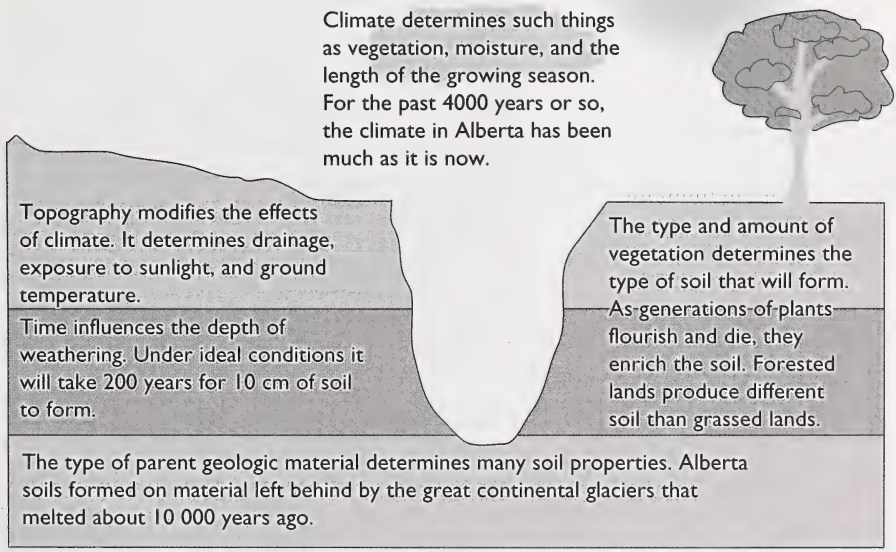
h. This provides bacteria with a source of nitrogen, so they can produce nitrates.

i. It provides decomposers with oxygen so they can produce plant nutrients.

j. Plants use it to dissolve and carry wastes from their cells.

Compare your answers with those in the Appendix, Section 2: Extra Help.

The following factors influenced formation of soils in Alberta.


Climate determines such things as vegetation, moisture, and the length of the growing season. For the past 4000 years or so, the climate in Alberta has been much as it is now.
Topography modifies the effects of climate. It determines drainage, exposure to sunlight, and ground temperature.
Time influences the depth of weathering. Under ideal conditions it will take 200 years for 10 cm of soil to form.
The type and amount of vegetation determines the type of soil that will form. As generations of plants flourish and die, they enrich the soil. Forested lands produce different soil than grassed lands.
The type of parent geologic material determines many soil properties. Alberta soils formed on material left behind by the great continental glaciers that melted about 10 000 years ago.

2. From what type of parent material did Alberta soils develop?

3. What type of climate does Alberta have?

4. How do soils developed under grassland differ from forest soils? Why?

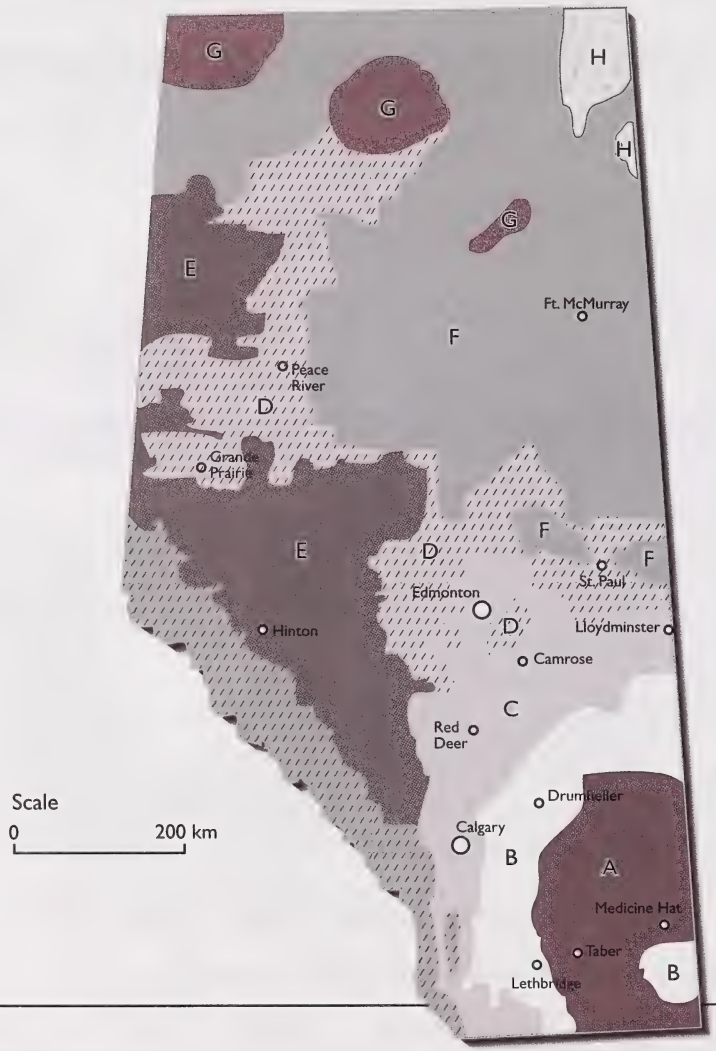
Compare your answers with those in the Appendix, Section 2: Extra Help.

In Alberta, there are nine soil groups. Five of those soil groups are used for agricultural purposes:

- brown chernozemic soils
- dark-brown chernozemic soils
- black chernozemic soils
- dark-grey chernozemic soils
- grey luvisolic soils

5. Look at the following map of Alberta. Find the five soil groups used for agriculture. Match the letters on the map with the appropriate soil group name.

Soil Group Map of Alberta



Compare your answers with those in the Appendix, Section 2: Extra Help.

Soils are valuable resources; therefore, they must be managed properly. Part of any good management system is to identify problems and address them before they get out of hand. When it comes to agricultural use of soils, two major problems have been identified. One is loss of soil nutrients and the other is soil erosion.

6. Choose one of the problems associated with agricultural use of soil. Explain how agricultural practices contribute to the problem. Then discuss two responses that are being practised by farmers to solve the problem.

Compare your answer with the one in the Appendix, Section 2: Extra Help.

Enrichment

The ingredients, or parts, that make up a successful compost generally fall into one of two categories—"browns" and "greens." Browns are dry materials such as wood chips, dried leaves and grasses, or straw that are high in carbon content. Greens are fresh, moist materials that are high in nitrogen content. In addition to the browns and greens, your compost needs water, oxygen, heat, and living organisms such as bacteria and insects.

There are many ways to go about composting. One approach is described here.

Composting

A. Collect equal amounts of browns and greens to start the compost pile. Be sure to use only plant materials in your compost. **Do not** use animal materials like meat scraps, in your compost pile. They will make your pile reek and will attract pests like houseflies.

B. Place equal amounts of browns and greens in a heap or in a specially made compost bin directly on the ground. Your compost pile should be about 1 m^2. Any food scraps used should be covered by other plant materials.

C. Soak your compost pile with water to a uniform dampness. Your pile should be about as damp as a wrung-out sponge.

   If you are using a bin, close the lid to keep the moisture in and to create a suitable environment for bacteria and insects to work.

D. Turn your pile over three or four times during the composting period. This allows oxygen to enter the pile. The oxygen is needed by living organisms working to decompose the plant material.

   The length of time it takes to convert raw materials into compost varies. Compost may be ready for use in as little as a month, or it may take as long as 12 to 24 months. Factors affecting the results include the technique used, seasonal temperatures, the balance of nitrogen (green material) and carbon (brown material), and the moisture level.

   When the compost is ready to be returned to the earth, it will look black or dark brown. It will be crumbly and have the aroma of good earth. In this state, it is a perfect additive for garden soils or potting soils.

1. Use the preceding method to create a compost pile of your own. To help you understand the processes going on, try to observe your pile as it goes through the composting cycle. Keep a journal of your observations. Record anything you find interesting about your pile. You are encouraged to discuss your observations with someone you know.

   If your situation does not allow you to complete this activity, complete question 3, which is a small-scale composting experiment.

Only 7% of the available land in Canada is suitable for agriculture. Usually large communities are located in the middle of the best agricultural lands. As these communities expand, they use more and more arable land.

2. Why would most of Alberta's major cities be located on the best farming land?

3. To observe how plants decay, place one layer of moist soil (1–2 cm) into a small jar. Cover the soil with a layer of sand. Cover the sand with a layer of peat moss. On top of the peat moss, place a few green leaves and two or three earthworms. Make several holes in the jar lid before attaching it to the jar. Then place the jar in a garbage bag for shade. Leave the bag and jar at room temperature for five days. At the end of five days, open the bag and look closely at the contents of the jar. Record your observations.

   You may want to repeat this experiment using different plant materials.

Compare your answers with those in the Appendix, Section 2: Enrichment.

CONCLUSION

In this section, you became aware of what components are found in soils, how soils are formed, and how they are classified. You should now recognize that soil is a valuable resource that needs to be managed properly. You should be aware of problems associated with the agricultural use of soils and how these problems are addressed.

There actually is very little soil that is useable for agricultural purposes. Therefore, it is very important to care for this resource. A world without soil would be a world without plants, animals, and people.

Much of Earth's surface is covered by land that isn't arable or useable. This surface consists of bodies of water, bogs, deserts, mountains, polar icecaps, and rural and urban development. Some of the surface is found in areas that are too cold, wet, or rocky to be useable. If Earth is compared to an orange, the amount of land that is arable is equivalent to 1/32 of an entire orange peel.

ASSIGNMENT

Turn to your Assignment Booklet and do the assignment for Section 2.

Land Management

AAFRD, CONSERVATION AND DEVELOPMENT BRANCH

If you owned a section of land in Alberta, what would you do with it? There are a variety of options from which you could choose. You could build a house on the land and live there. Maybe you could build a golf course on the land. You could sell the land to urban developers. You could farm the land. What you would do with this land would depend on your interests and priorities. Much of your decision, however, would be based on what the land is like.

There are many different land forms and land uses in Alberta's 660 190 hectares of vast and varied land. Within its borders you will find semi-deserts, wetlands, and glaciers. There are also plains, coulees, hills, and mountains. You will also find many different bodies of water, not to mention grasslands and forests. There are uninhabited wildernesses and populated cities. In Alberta, how land is used is an important issue.

In this section, you will discover the many uses of land in Alberta. You will also be introduced to several land uses and the conflicts that arise between different users. You will examine how decisions are made regarding land use. As well, you will look at different land-use strategies. Finally, by looking at a case study, you will be given a chance to determine how a certain piece of land could be used.

SECTION 3

ACTIVITY 1

Land Uses

Although Alberta has a large land base, that land base has limits. There is only so much land available for the many different uses. Some of the current uses for Alberta's land include the following:

- agriculture
- oil and gas extraction
- mining
- forestry
- recreation
- transportation
- urban development
- wildlife habitat

Agriculture

About one-third of Alberta's land is used for agricultural production. Agriculture directly employs about 89 000 people and is responsible for contributing billions of dollars to the provincial economy.

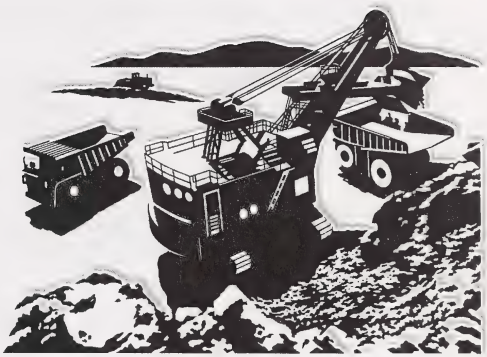
Agricultural lands are used to grow crops and raise animals. Products of these activities include food, clothing, glues, fuels, waxes, medicines, and building materials. Much of the food produced in Alberta is exported to other provinces and other countries. Because agriculture produces so much useful material, it is ranked near the top of land uses.

Oil and Gas Extraction

From an economic point of view, the oil and gas industry is number one. It accounts for one-half of Alberta's total export sales.

Products derived from this industry include fuels like propane, natural gas, and gasoline. The plastic industry is dependent on the production of oil and gas. In fact, most industries rely on the energy supplied by the oil and gas sector. Because oil and gas provides energy for nearly all industries, it is usually given preference when it comes to land use.

Mining



Many materials, including coal, sulphur, sand, gravel, salt, and gold, are mined in Alberta. Coal is mined more than any other material. Alberta's coal is used in making steel and burned to produce electricity. Much of it is exported to other countries.

Forestry

The forestry industry is expanding and becoming increasingly important to Alberta's economy. Did you know that chemical wood pulp was one of Alberta's top-ten export goods in 1995?

Recreation

Throughout the year, Albertans can participate in a wide variety of recreational pursuits like hiking, skiing, and boating. What kind of activities do you enjoy? Land must be set aside for each activity you take part in, whether it be basketball, bowling, bicycling, fishing, or golfing. They all require space.

Transportation

The province of Alberta covers a huge area. That makes it necessary to set aside land for a transportation system. Roads, highways, airports, and railway tracks are needed to move people and goods from one place to another.

Urban Development

People have to live someplace. Land must be set aside for their homes. Because many people live close to their work, urban areas must set aside land for industrial and commercial purposes. Other urban land uses include transportation and recreation. Urban areas use land very intensely with many different activities taking place in a small area.

Wildlife Habitat

Wildlife habitat is shrinking daily because of human activity. Mining, agriculture, urban expansion, and other land uses are reducing the amount of land available to wild animals. In an effort to preserve natural habitats, governments have passed legislation, such as Alberta's Wilderness, Ecological Reserves, and Natural Areas Act. So far, 64 000 km^2 of land have been protected for wildlife habitat. When it comes to land use, wildlife must depend on humans to make wise choices.

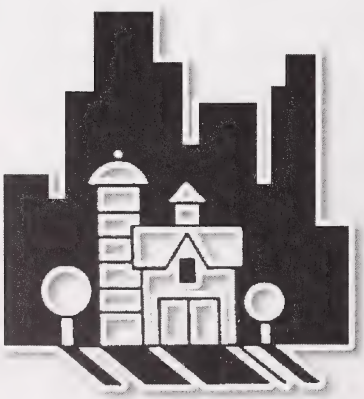
1. Identify the type of land use for each of the following:

   a. uses land most intensely
   b. contributes the most to Alberta's economy
   c. is at the mercy of human wisdom
   d. is necessary for moving goods and people
   e. is not essential for survival but fun to have

Compare your answers with those in the Appendix, Section 3: Activity 1.

Land-Use Conflicts

Conflicts are bound to arise between different user groups because there is a limited amount of land available. In most cases, land used for one purpose excludes the use of that land for other purposes. For example, land set aside for housing means that no strip mining can take place there. Strip mining is incompatible with a quiet, domestic setting.



When it comes to agriculture, there are many conflicts. One of the big conflicts is between agriculture and urban development. Since most communities in Alberta are located on prime agricultural land, any expansion of these communities will withdraw good land from production. This conflict is not easy to resolve since both uses are important and both are mutually exclusive.

Ethics

2. Do you think prime farmland located around cities and towns should be used for food production only? Why?

3. If you answered yes to question 2, how would you meet the growing needs for urban expansion? If you answered no to question 2, how would you meet the need for more farmland and food production?

Compare your answers with those in the Appendix, Section 3: Activity 1.

Multiple Uses of Lands

LORRAINE SPREADBURY

Some lands accommodate several uses. A good example is a water reservoir. Water from a reservoir can be used for agriculture, recreation, urban development, and industry. Agriculture uses water from reservoirs to irrigate crops and water animals. Recreational uses for reservoir water include boating and fishing. Urban centres use reservoir water for drinking water. Industries use reservoir waters for processing goods. In addition, the water can be used to generate electricity. The controlled release of waters can also prevent unwanted flooding. Therefore, reservoirs are definitely multi-use areas.

However, there are two major disadvantages to constructing reservoirs. One is that it is an expensive undertaking. It costs millions of dollars to purchase the lands being flooded and to build the necessary dams. Another disadvantage is that reservoir waters cover lands that would have been used for dryland wildlife, agriculture, urban centres, forestry, or mining.

4. What is an advantage of creating a reservoir?

5. What are some disadvantages of creating a water reservoir?

Compare your answers with those in the Appendix, Section 3: Activity 1.

Parks are lands with many uses, too. Most parks are set up as wildlife habitats and recreation areas. Some parks have commercial enterprises and urban development.

Some agricultural lands have multiple uses. For example, the oil and gas industry and the agricultural industry have gotten along well for many years. Pipelines are usually far enough underground that they do not hinder farming practices, and any above-ground activities are confined to small parcels of land. Therefore, agriculture is able to carry on without much interference.

Another land use that is not too disruptive to farming is wildlife habitat. More farmers are trying to integrate wildlife habitat into their farms. They see it as a benefit to society and themselves. Natural settings being tended by farmers include shelterbelts, secluded ponds, marshes, and small forests.

Hiking in grazing areas is another example of how farmland can be used for more than one purpose. As long as hikers respect the land, refrain from bothering animals, and remove all garbage when they leave, there is little conflict. However, cropping practices exclude all other activities. Farmers would not want people playing soccer in their wheat field. It would damage a valuable crop and the resulting compaction of the soil would make cultivation more difficult.

Inner Conflicts

Multi-use lands are often a compromise between user groups—a compromise in which no user group is completely satisfied. A case of this is Banff National Park and Jasper National Park. Although these parks have been designated for wildlife habitat, they have other uses going on within their boundaries including tourism, recreation, commerce, and urban development.

In 1996, the national parks were under considerable pressure to allow expansion of commercial enterprises. Commercial enterprises wanted to expand to accommodate growing numbers of park visitors. In order to meet the growing demand, they wanted to use more of the wildlife habitat for commercial purposes.

The Canadian park system looked at the situation and came up with a plan that it thought would be best for the parks. They decided to restrict the number of users rather than expand commercial facilities aimed at servicing more visitors.

It was a tough decision, because those lobbying for expanded commercial development had some sound arguments. Expanding visitor services would not only accommodate more visitors, it would add money to the economy, increase the number of jobs for Canadians, and provide everyone with more recreation facilities. However, the original purpose for the parks was to provide wildlife habitat and that was the major criteria for the decision.

Read the following article. It provides more information on what was decided for Banff National Park.

Curbs to Banff growth get thumbs up

MONICA ANDREEF
and MONTE STEWART
Calgary Herald

Banff

Banff National Park's cadet camp and air strip will be closed, but visitors can still hike, ski, fish, and drive the Bow Valley Parkway under a Parks Canada compromise plan released Friday.

About half the 500 recommendations in the 27-month Bow Valley Study released last fall will not be implemented, including quotas of fewer than 100 people per month on hiking trails and the summer closing of the secondary highway that runs through the park.

After public meetings Friday and today, Parks Canada will begin drafting a management plan for Banff to be tabled in the House of Commons in April, said park superintendent Charlie Zinkan.

"We don't want to study things forever, we need to make some decisions," Zinkan said.

But Banff Flying club president Bernie Schiesser vowed to fight the closing of the air strip. "It's not done until it's done," he stated, saying the grassy strip used since the 1930s is a safe haven for pilots in bad weather. He disputed environmentalists' assertions it blocks wildlife movement.

But Alberta Wilderness Association past-president Cliff Wallis of Calgary said most park stakeholders want the air strip and camp closed to aid wildlife migration. He said increased mobility should enhance the area's population of bears and cougars, in turn helping control its burgeoning elk population.

The Bow Valley Study, released Oct. 7, was criticized by many park users as overly protective of the environment, to the exclusion of park users. But Ladd Snowsell, a member of the study's round table, which included representatives from environment, business and user groups, said the plan won't unreasonably limit people's enjoyment.

"Parks has taken some good actions toward addressing the purpose of the park—which is for people to experience it while protecting the wildlife and nature of the area," he said.

Harvey Locke, former Canadian Parks and Wilderness president, characterized proposals to limit park use as a "course correction."

"I won't click my heels and say it's perfect, because it isn't, but it is some

PARK PLAN

HIGHLIGHTS:

- Buffalo Paddock, airstrip, horse corrals, cadet camp north of Banff will be removed; Timberline Lodge and Norquay Road will remain open.
- Mountain biking trails around Johnson's Lake (near Lake Minnewanka) will be closed; lakeshore will remain open for beach use in summer.
- No new hostels or hotels.
- Most trails and backcountry facilities will be maintained at current levels; Skoki Lodge trail will become a prototype for a reservation system.
- No fencing of Banff townsite, the golf course and campgrounds.
- Special tax to cover environmental initiatives is cancelled; user fees to cover services that offer a personal benefit to visitors will continue.
- Bow Valley Parkway to stay open; winter closure from just west of Banff to Castle Junction.
- Proposals to build a meeting facility at the Chateau Lake Louise to proceed; Lake Louise will remain a visitor service centre with overnight accommodation capped at 3,500 and no new development.
- Development of the area's three ski hills will continue along approved long-range plans; summer-use proposals at Banff Mount Norquay will not be allowed and Skiing Louise's summer program is under review.

meaningful movement and direction. It's what we really need to see here, to get Banff back in the family of national parks."

The report considered only 350 of the study's 500-item wish list.

The study's recommendations to curb commercial and residential growth and cap the Banff's population at 10,000 were redundant, said town Mayor Ted Hart. "Perhaps the study turns up the heat ... but it is not dissimilar from what we've been trying to accomplish all the way along."

Colin Funk, vice-president of Bow Valley naturalists and a Banff resident, said people have had two years to air their concerns and must accept reduced access in exchange for a "model" community.[1]

6. Parks Canada made several decisions regarding Banff National Park's future. Name three that were made that would have a positive effect on wildlife habitat.

Compare your answer with the one in the Appendix, Section 3: Activity 1.

Land set aside for urban development is another good example of where inner conflicts occur. For example, housing development and industry are often in disagreement on land-use issues. Transportation and wildlife habitat are two other uses that are often in conflict.

Deciding on the best use for a piece of land is difficult. In the next activity you will find out how decisions are made.

[1] Monica Andreef and Monte Stewart, "Curbs to Banff growth get thumbs up," *The Edmonton Journal*, 25 January 1997, B5. Reprinted by permission of the Calgary Herald.

ACTIVITY 2

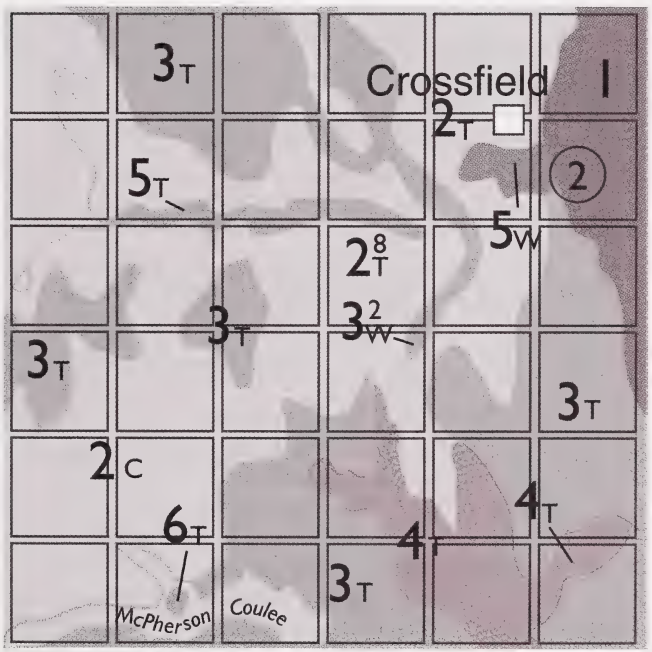
Deciding on Land Use

How do people decide what is the best use for a piece of land? Decisions about land use are made by governments, organizations, and individuals. In most cases, the decision comes about through a concerted effort by a number of people. The process starts by preparing a thorough description of the land.

Wise decisions require pertinent information. One source of useful information is the Canada Land Inventory system. The Canadian government undertook detailed land surveys in Canada. The result was a database that rates lands based on a number of criteria.

One criteria is agriculture use. There are Canada Land Inventory maps that rate lands across the country based on their ability to produce crops. The ratings go from one to seven with areas rated one being the best areas for cropping and areas rated seven being unsuited for agriculture.

Sample Portion of a Canada Land Inventory Map



Decisions regarding the use of Crown lands, those lands owned by the government, come about through a public process. A panel is appointed to examine the issue and make a final recommendation to the government. Everyone who has an interest in the land is invited to make presentations to the panel. Interested parties present papers or make oral submissions to the panel. In addition, environmental impact studies are conducted to see what the long-term effects of a particular use will be on the land.

An environmental impact study (EIS) looks at the need for the proposed project. It examines all other land-use options, and it evaluates the environmental damage that may result should the project be approved. Some environmental studies suggest ways to improve the project to reduce or eliminate environmental damage.

An example of how a land-use decision is made is the case of the Cheviot Mine proposal. A coal-mining operation applied to mine coal from a parcel of land near the town of Hinton. The mine would be operating within 2 km of Jasper National Park. The government set up a panel to investigate the application. Public hearings were held and presentations were made by those who were in favour of the mine and by those who opposed it. An environmental impact study was done to determine the mine's effect on the surrounding countryside.

Reasons in favour of opening the mine included the following:

- The new mine would provide jobs for many workers now employed at the old mine.
- The mine would extend the economic benefits enjoyed by the area. The old mine was running out of coal. If the new mine were not allowed to begin, many workers would lose their jobs, and local businesses would suffer reduced incomes due to a shrinking market.
- The new mine would not have a major permanent negative impact on the environment. Although the natural setting would be disrupted during the mining process, after the coal was extracted, the land would be restored to a natural state.
- The mined material would be sold to other nations, which would contribute towards a favourable balance of trade. A favourable balance of trade contributes to the good of all Canadians, because it pays for such things as health care, education, and defense.
- The land is not being used at the moment for any particular purpose other than wildlife habitat and possibly some recreation.

Reasons for opposing the mine included the following:

- Mining disrupts the natural habitat for years. Several species would be affected.
- Restoring the land to its original state is impossible.

- Mining exposes soil to erosion. Eroded soil enters streams, rivers, and lakes clogging them and interfering with aquatic life.

- Coal from the mine will be burned causing increased air pollution and increased problems associated with global warming.

- Coal mining has a negative effect on tourism: it reduces the land base used for recreation.

Read the following article for more information on the proposed coal mine.

First salvos in the Cheviot fight

Greens try procedural wrangling as an opening gambit, frustrating local mine supporters

The town of Hinton, located 170 miles west of Edmonton, offers a picture perfect glimpse of peaceful rural Alberta. But the look is deceiving. This town of 10,000 feels it is fighting for its economic existence against an international alliance of environmental groups intent on cutting its lifeline to the future. At issue is the Cheviot Mine, a proposed coal development less than two kilometres from the border of Jasper National Park. Last week greens lined up against miners and townsfolk at a regulatory hearing, a bitter grudge match which will determine whether Cheviot proceeds.

Cheviot is sponsored by Cardinal River Coals (CRC). The company now operates the Luscar mine near Hinton but its reserves are expected to run out shortly after 2000. CRC, a partnership of Luscar Ltd. of Edmonton and Consol Canada (itself a subsidiary of a major American firm), wants to create new work for its 450 Luscar workers. The Cheviot mine was shut down in 1950 after 39 years of operation, but still contains an estimated 65 million saleable tonnes of steel-making coal. The reopened mine will cost $250 million to develop over three years, create 900 construction jobs, produce 3.2 million tonnes of coal a year, and generate estimated royalties of $122 million over its 20-year life.

About 200 individuals gathered at Hinton's Crestwood Inn on January 13 for the first day of an expected four-week public hearing before a joint federal-provincial panel. Representing the eco-enthusiasts were the Alberta Wilderness Association (AWA is spear-heading a group effort on the issue) and the Rocky Mountain Ecosystem Coalition (RMEC). Notably absent was Harvey Locke, lawyer, perennial eco-hearing participant, past president of the

Canadian Parks and Wildness Society and president of the Alberta Liberal Party. On behalf of CPAWS, Mr. Locke has vigorously championed limits to industrial development in the Rockies. As a Liberal, however, Mr. Locke is no doubt aware that West Yellowhead (which includes Hinton) is currently represented by Liberal MLA Duco Van Binsbergen.

Waste rock at the Luscar mine: Where to dump the stuff is a key issue.

Arguments at the hearing opened with legal wrangling between Michael Sawyer, executive director of RMEC, and Denny Thomas, legal counsel for CRC. Mr. Sawyer alleged that the three-member panel had been constituted unlawfully because federal Environment Minister Sergio Marchi had not personally set the terms of reference for the hearings. The RMEC chief also claimed that the public registry, essentially a library containing all material filed with the government related to the review, had not been set up until December 23, two months later than required. Therefore, he asserted, environmental groups had not had sufficient time to analyze such documents as the 12-volume environmental impact assessment filed by CRC.

It was not the first time Mr. Sawyer had made such charges. The week before the hearings began, Associate Chief Justice James Jerome of the Federal Court of Canada rejected RMEC's bid to delay the hearing. He stated that Mr. Sawyer had known about the hearing for some time, and suggested he bring the issue before the panel.

However, Mr. Sawyer's allegations met a dead end there as well. On day two of the hearing, panel chairman Brian Bietz denied his request for an adjournment. He referred to a letter from Minister Marchi dated November 22, confirming that he had set the terms of the panel. He added that public notice was sent out July 16, at which time documents could be obtained free of charge from the applicants, providing ample time for review.

But Mr. Bietz agreed later the same day to adjourn the hearing until January 22, due to the Alberta Wilderness Association's request for additional time to review new documents only recently submitted. Mr. Sawyer says the panel was trying to avoid the legal issues he had addressed. "It's a lot easier to give an adjournment on the basis of being good guys rather than breaking the law." He plans to take the issue to federal court again.

CRC's Thomas says "[Mr. Sawyer] spouts pseudo-law and pseudo-science. His claim is completely bogus and contrived." He claims RMEC had ample time to gather the information. "On May 9, 1996, he [Mr. Sawyer] received the project summary and reviewed the application in CRC offices. And on May 13, the full application was sent to him via courier." Despite the delays, Mr. Thomas still anticipates the hearing will be "wrapped up no later than February 7."

"We're not very happy with the delay," says Brent Bish, president of the United Mine Workers of America Local 1656. "We had to be ready on time, and we don't understand why these other groups aren't." Nor does he think the greens "have any intention of working with the company." Mr. Bish says that is unfortunate, considering CRC's environmental record. "I've worked for

a lot other mines," he reports, and they are "flabbergasted" at CRC's environmental accomplishments. CRC has won three environmental awards since 1989, including the "Citation for Reclamation Performance" in 1995 from the Alberta Chamber of Resources.

The Town of Hinton will submit a study conducted by Nichols Applied Management of Edmonton on the possible impact if Cheviot is not approved. Nichols concluded that without the replacement mine, Hinton would lose more than 15% of its population due to 60% of CRC employees leaving the area. Consequently, the consultant asserts, local housing prices would drop by up to 30%. "We're taking a balanced point of view," says Hinton Mayor Ross Risvold. "We need to look at both the socioeconomic and environmental aspects. We feel comfortable that a lot of the environmental concerns can be mitigated."

More ambivalent is Mike (Spike) Bracko, a retired former plant manager at Luscar. He frets about "needless destruction" which could be caused by Cheviot. "My main concern is that they are going to dump debris into the adjacent valley, and when they do that, they cover the streams." However, Mr. Bracko is not completely opposed to Cheviot. "I'd like to see them do it right. Put the rock back in these big cavities they are digging in the earth, and make the landscape as close as it was to when they began there."

Bill Hume, CFC general manager, says that is exactly what his firm has in mind. "We're maximizing the amount of backfilling that we can do. It is more economic and better for us." The mine will contain 22 pits and dump space from the previous mine is also available. But rock swells 20% after it is blasted, so "there is a genuine need for outside dump space [as well]," asserts Mr. Hume.

Greens, however, feel those assurances are outweighed by the need to protect the ranges of grizzly, wild sheep and other major mammals. In early January the proposed mine site was visited by Don Seligman, a lobbyist for the Sierra Club in Washington, D.C. RMEC's Sawyer has long promoted the possibility of American action against Canadian exporters in the name of protecting the Canadian Rockies, a name of mythic proportions south of the border. Mr. Seligman said it was too soon to discuss strategy but he felt that U.S. greens would likely step into the Cheviot fray in one form or another.[1]

1. What information would you expect to be included in an environmental impact study conducted for the Cheviot Mine proposal?

Innovation

2. If you were on the panel making the decision about the mine, would you vote in favour of the mine or would you vote against it? What would be your reasons for voting one way or the other?

3. How do government planners decide where to put recreational areas?

4. Identify four different recreational areas in your region.

Compare your answers with those in the Appendix, Section 3: Activity 2.

You may wish to explore the Cheviot Mine proposal further. What were the decisions that came out of the hearings? Has the mine been approved? Alberta newspapers, magazines, and media outlets are sources you can check for information about Cheviot.

[1] Joshua Avram, "First Salvos in the Cheviot Fight," *Alberta Report*, 27 January 1997, 21–22. Reprinted by permission of United Western Communication Ltd.

The use of private lands is guided by local governments. Local governments pass zoning bylaws that designate how lands within their jurisdiction may be used. Landowners can make many decisions about how to use their lands as long as those uses fall within the guidelines provided by the bylaws.

If landowners wish to use lands for purposes outside of the bylaws, they must apply to the local government for an exemption. To get an exemption, the case must go through a public hearing. The public must be notified of the proposed exemption, especially those people living next to the affected land. All interested parties must be given a chance to voice their opinions on the proposed land use. The application will be turned down if there is enough opposition to the project.

Once the decisions are made about land use at the local government level, landowners may make many decisions on their own. For example, farmers can make the following decisions about how their land is used:

- what areas will be used for production
- what crops will be grown
- how the land will be cultivated
- whether commercial chemicals will be used
- when each operation will take place
- when and how to harvest the crops

5. Where should a landowner go to find out what he or she can do with a parcel of land?

Compare your answer with the one in the Appendix, Section 3: Activity 2.

In Alberta, land is plentiful but not without limits. Because it is limited, there is competition between different users for the land. Governments, interest groups, users, specialists, and individuals must work together to make sound decisions about land use. In order to do that, they need tools.

Among the most useful tools used in deciding how to use land are Canada Land Inventory maps, environmental impact studies, and zoning laws. Those interested in how lands are used can use these and other tools to produce an allocation system that

- guides landowners in the best use of their properties
- ensures neighbouring lands are not harmed by land usage
- provides an avenue to resolve conflicts between interested parties
- provides information to those making decisions on land use
- controls development
- avoids depletion of natural resources
- ensures common resources are shared equally; e.g., ground waters and surface waters

ACTIVITY 3

Land-Use Strategies

People must decide how to use their land resources in such a way as to not jeopardize future generations. These decisions are not easy to make because there are many different uses for one parcel of land. In the case study that follows, you will decide on how a particular piece of land will be used. Read the case study; then answer the questions that follow.

Case Study

Karen Nasik is a part-time farmer in central Alberta. She raises beef cattle and horses on a half section of land. She does some off-farm work as an accountant in a nearby town. She has been farming for six years.

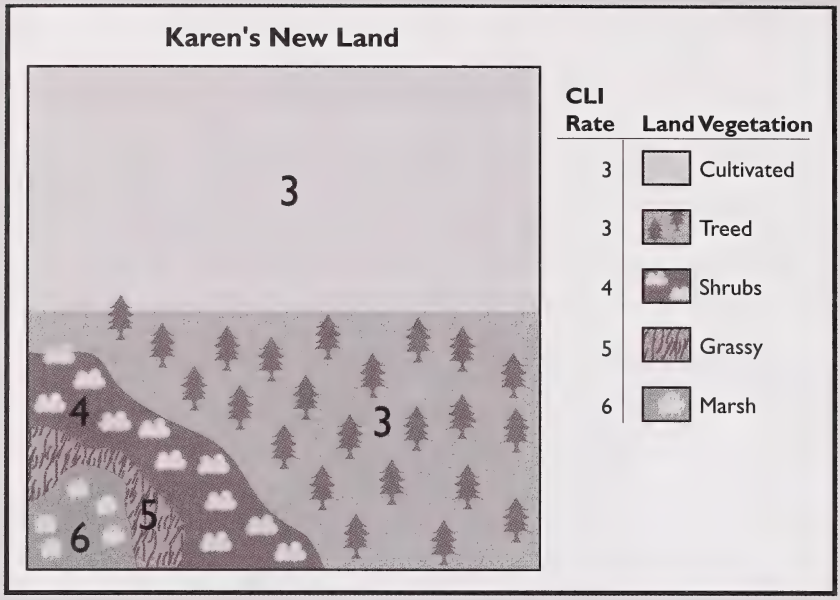
Karen uses her land to pasture animals and to grow crops. The number of animals in her herds has steadily increased to the point where her land base is too small. An opportunity came up to buy a quarter section from a neighbour. The price was a little high for farmland, but Karen purchased the land anyway, paying the premium for the convenience of having adjoining lands.

Description of the Land Purchased

According to the Canada Land Inventory map, the majority of the land is rated Class 3 agricultural soil, which means it is good land for crop production. Half of the land is currently under cultivation. The other half is mostly covered by trees. In one corner, there is a marsh. The marsh is about 10 ha in size. It supports several different species of birds and serves as a water source for area wildlife.

The cultivated half of the new land was poorly managed for many years. This resulted in visible soil erosion, loss of organic matter content, and decreased fertility.

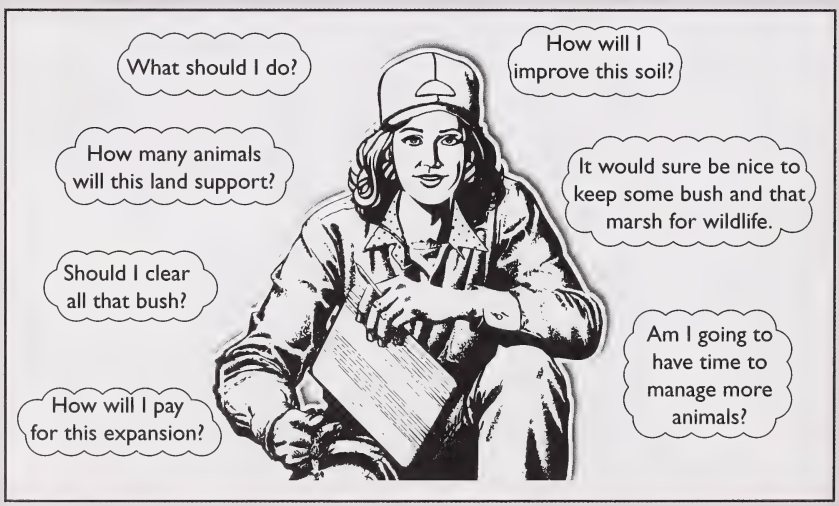
Karen had the local agrologist do a number of soil tests on the cropped area and the results confirmed that the land was deficient in soil nutrients and organic matter.



The Area's Climate

An agro-climatic map of the area indicating precipitation and the number of frost-free days shows the land is in an area with adequate moisture and there are between 75 to 90 frost-free days.

Personal Goals


What should I do?
How will I improve this soil?
How many animals will this land support?
It would sure be nice to keep some bush and that marsh for wildlife.
Should I clear all that bush?
Am I going to have time to manage more animals?
How will I pay for this expansion?

Karen wishes to increase her farming operation so it becomes more economically viable. She hopes to increase the number of animals she raises by 50 animals and sees the new land as a means of reaching that goal. However, she does not want to overexploit the land resources.

Karen would also like to stay away from having a large debt load. Her job as an accountant is insecure. One of her reasons for expanding is to be able to make a living from the farm operation alone.

Karen has a range of options open to her regarding the use of the land. Presented here are two options open to Karen. Option A requires a minimum amount of effort and preserves the land much as it was when she brought it. Option Z, on the other hand, requires much effort and is geared to maximizing agricultural production from the land. Karen can choose to go with either option or choose to do something in between the two extremes.

Option A

One option is to use the open land as pasture and do nothing further. Karen could seed the area to grasses, or a mix of grasses and clover, and allow animals to graze freely. Benefits for this option include the following:

- This option would require no further capital outlays.
- Using the land as pasture would allow the soil to recover.
- Grazing animals would deposit manure on the land, which could be incorporated into the soil.
- Roots of plants growing in the pasture would add organic matter to the soil.
- The plant covering would prevent further erosion.
- Animals could roam in the forested area, which would afford them protection from harsh weather conditions.
- Forested areas may help animals get away from biting insects and mosquitoes.
- Animals would be able to get some of the water they need from the marshy area.
- This option would allow her to raise 20 more animals.
- It would allow her to repay the $50 000 loan she took out to buy the property in 15 years.

One of the problems with this option is that she would have to continue to work off the farm to earn enough money to make a living.

Option Z

At the other extreme she could utilize the whole quarter section by clearing the rest of the land and draining the marshland. This option has the following advantages:

- She could sell the trees to a pulp mill and raise $10 000.
- She could raise an extra 50 animals.
- If markets remain steady, she would be able to live on the extra farm income.
- With the whole quarter open, field work would be more efficient.

This option has the following disadvantages:

- Karen would have to get another $35 000 loan.
- It would require Karen to cut back on the hours she works at her accounting job, and she may lose her position because of that.
- She would be in debt for 25 years if the current interest rate, animal prices, and expenses remained stable.
- The whole field would be exposed to soil erosion.
- Wildlife would be pushed off the land.

Karen could do a number of things in between these two options. For example, she could keep the marshland, clear part of the treed area, and use the currently open land as pasture. This option would be less expensive than Option Z. Unfortunately, it would not allow her to reach her goal of raising 50 extra animals.

1. If Karen came to you, would you advise her to go with Option A or Option Z in the first year?
2. What would you recommend Karen do to the land in two to five years?
3. Why is planning and research necessary when making a land-use decision such as for Karen's new property?
4. List two advantages and two disadvantages of draining the marshland and growing crops on it.

Compare your answers with those in the Appendix, Section 3: Activity 3.

Steps in the decision-making process include

- gathering information and identifying issues
- setting goals and priorities
- examining the available options
- making decisions that maximize the highest and best use of the land

If you wish to learn more about land use in Alberta, you can contact your local government and ask them for more information on land use bylaws. Or you may wish to search for information on the Internet under the words *land use*. You will find many interesting sites by going to the following address and then searching under the words *land use*.

http://www.agric.gov.ab.ca/cgi-bin/wwwwais

Note that this address is subject to change.

In this activity you had a chance to review information about a parcel of land and make recommendations as to how it should be used. You took into account details about the land and the owner's goals and preferences. Your recommendation should result in the best use for the land.

FOLLOW-UP ACTIVITIES

If you had difficulty understanding the concepts in the activities, it is recommended that you do the Extra Help. If you have a clear understanding of the concepts, it is recommended that you do the Enrichment Activities.

Extra Help

The case that follows takes you through a real-life situation involving land use. Read the case and answer the questions that follow. Doing so will help you review the main points covered in Section 3.

Case Study

Alberta Transportation and the Wagner Natural Area

In 1989, Alberta Transportation decided an overpass and service road was required near the Wagner Natural Area, located just west of Edmonton. Although the new roadway would not have passed through the Wagner Natural Area, it would have affected the water supply to it. The new road would also have damaged and killed some plant forms that were rare in the area.

When the plan for the highway development was released to the public, an environmental group foresaw the potential danger to the natural preserve. The environmental group lobbied Alberta Transportation to do an in-depth environmental study to determine the long-range impact of the proposed road on the environment. Alberta Transportation completed the study, which indicated that by moving the proposed location of the roadway further east they could minimize environmental damage and still provide the roadway needed to fulfil transportation needs.

By working together, the two groups were able to make a land-use decision with which they both could live.

1. Look up the verb *lobby* in a dictionary. Now write a definition for the phrase *lobby group*. What role do you think lobby groups play in land-use decisions?

2. What two user groups were in conflict over the overpass and service road being proposed for the Wagner Natural Area?

3. What did the environmental impact study reveal about the project?

4. How was this issue resolved?

Compare your answers with those in the Appendix, Section 3: Extra Help.

Enrichment

The world in which you live depends on constant growth. The trouble is that Earth has limited resources. Therefore, the resources that are available on Earth must be conserved. The implications of this reality are as follows:

- A limit must be set for the human population.
- Eventually Earth's natural resources will be exhausted.
- Proper management can make the limited supply last longer.
- As Earth's population increases, so will the conflict between land users. Wise decisions made now may reduce conflicts in the future by conserving and preserving lands for future use.

1. For each of the following, describe one way you might preserve the resources into the future.

   a. a forest of prime timber
   b. agricultural land being considered as a site for a coal mine
   c. a wilderness area being considered for a hydroelectric project

Compare your answers with those in the Appendix, Section 3: Enrichment.

Wildlife, including birds and animals, need space to live. Often, less-productive farmland can be better utilized to provide a habitat for waterfowl than it can to grow crops for food.

Have you ever seen marginal land being used as a wildlife habitat? Farmers can improve or protect wetland areas through land management. Ponds and sloughs can be left as permanent bodies of water. Green zones can be maintained around the water areas to be used as nesting sites. Sometimes, farmers place hay or straw bales into a swamp for use as a nesting island for geese. The waterfowl population increases if it is provided with a safe nesting site.

In Canada, a conservation group called Ducks Unlimited is dedicated to the preservation of wetland areas. This group encourages farmers to plant what is known as cover crops, such as hay, around permanent sloughs to provide protection from predators and nesting sites. This practice not only benefits the waterfowl, but also benefits the farmer by helping prevent erosion.

2. Contact a member of Ducks Unlimited, or another conservation group in your area, and see what is being done to protect wildlife and preserve wetlands in your area.

3. If you have access to a computer and the Sim City™ game, try building a model city. This game simulates how land-use decisions affect urban development. You should have a better understanding of the complexities of land-use planning after trying to build a model city using this simulation program.

Compare your answers with those in the Appendix, Section 3: Enrichment.

CONCLUSION

In this section, you discovered the many uses of land in Alberta and the conflicts that arise between different users. You examined how decisions are made regarding land use. You also looked at different land-use strategies. You were given a chance to use the knowledge you gained in this section to determine how a certain piece of land could be used.

Land is a very important resource. It directly or indirectly provides many important commodities that people need to exist—food, shelter, and clothing. Because Alberta has a large amount of land and a wide variety of types of land, it's important to understand how to manage land. It's particularly important to know how to manage land for agricultural purposes.

If you know the particular characteristics of a piece of land, it will be possible to make wise decisions about how to use that land. Of course, your decision may also depend on your own interests and priorities. You may have land of your own or be responsible for making land-use decisions—you now have some of the knowledge and skills to do this.

ASSIGNMENT

Turn to your Assignment Booklet and do the assignment for Section 3.

M • O • D • U • L • E S • U • M • M • A • R • Y

In this module you examined the management of water, soil, and land resources. In the first section, you discovered what water resources are available in Alberta, how those resources can have an impact on agriculture, and the importance of managing water resources. In the second section, you investigated soil resources in terms of composition, formation, classification, and management techniques. In Section 3, you explored the different uses of land, how to decide which use land should have, and strategies for managing and using land.

How water, soil, and land resources are managed can affect the agriculture industry in both beneficial and detrimental ways. These resources are very important to the agriculture industry in Alberta, but they are also important to society as a whole.

While the resources of water, soil, and land are very important to society and agriculture, they are also important to you as an individual. You are directly or indirectly involved in some of the issues concerning the management of these resources. You now have the knowledge to make responsible decisions regarding resource management. It's important that you don't take these resources for granted—after all, they are a gift.

Congratulations
on completing this module!
Resource Management

COURSE SURVEY FOR RESOURCE MANAGEMENT (AGR 1110)

After you have completed the assignments in this module, please fill out this questionnaire and mail it to the address given on the last page. This module is designed in a new distance learning format, so we are interested in your responses. Your constructive comments will be greatly appreciated, as future course revisions can then incorporate any necessary improvements.

Name _____ Age ❑ under 19 ❑ 19 to 40 ❑ over 40

Address _____ File No. _____

_____ Date _____

_____

Design

1. The Student Module Booklet contains a variety of self-assessed activities. Did you find it helpful to be able to check your work and have immediate feedback?

   ❑ Yes ❑ No If yes, explain.

   _____

   _____

   _____

2. Were the questions and directions easy to understand?

   ❑ Yes ❑ No If no, explain.

   _____

   _____

   _____

3. Each section contains Follow-up Activities. Which type of Follow-up Activity did you choose?

   ❑ mainly Extra Help
   ❑ mainly Enrichment
   ❑ a variety
   ❑ none

   Did you find these activities beneficial?

   ❑ Yes ❑ No If no, explain.

   _____

   _____

4. Did you understand what was expected in the Assignment Booklet?

   ❑ Yes ❑ No If no, explain.

   _____

   _____

5. The course materials were designed to be completed by students working independently at a distance. Were you always aware of what you had to do?

   ❑ Yes ❑ No If no, provide details.

   _____

   _____

6. This distance learning course may include an assortment of drawings, photographs, and charts.

   a. Did you find the visuals in this course helpful?

      ❑ Yes ❑ No Comment on the lines below.

      _____

      _____

   b. Did you find the variety of visuals in this course motivating?

      ❑ Yes ❑ No Comment on the lines below.

      _____

      _____

7. Suggestions for audiocassette, videocassette, and computer activities may have been included in the course. Did you complete these media activities?

❑ Yes ❑ No Comment on the lines below.

_____

_____

Only students enrolled in a Junior High course need to complete the following question.

8. The Student Module Booklet may have directed you to work with your learning facilitator. How well did you work as a team?

Student's comments: _____

_____

_____

_____

Learning facilitator's comments: _____

_____

_____

_____

Course Content

1. Was enough detailed information provided to help you learn the expected skills and objectives?

❑ Yes ❑ No Comment on the lines below.

_____

_____

2. Did you find the work load reasonable?

❑ Yes ❑ No If no, explain.

_____

_____

3. Did you have any difficulty with the reading level?

❑ Yes ❑ No Please comment.

4. How would you assess your general reading level?

❑ poor reader ❑ average reader ❑ good reader

5. Was the material presented clearly and with sufficient depth?

❑ Yes ❑ No If no, explain.

General

1. What did you like least about the course?

2. What did you like most about the course?

Additional Comments

Only students enrolled with the Alberta Distance Learning Centre need to complete the remaining questions.

1. Did you contact the Alberta Distance Learning Centre for help or information while doing your course?

   ❑ Yes ❑ No If yes, approximately how many times? _____

   Did you find the staff helpful?

   ❑ Yes ❑ No If no, explain.

   _____

   _____

2. Were you able to fax any of your assignment response pages?

   ❑ Yes ❑ No If yes, comment on the value of being able to do this.

   _____

   _____

3. If you mailed your assignment response pages, how long did it take for their return?

   _____

   _____

4. Was the feedback you received from your correspondence or distance learning teacher helpful?

   ❑ Yes ❑ No Please comment.

   _____

   _____

   _____

   _____

Thanks for taking the time to complete this questionnaire. Your feedback is important to us. Please return this questionnaire to the address on the right.

If you are enrolled at the Alberta Distance Learning Centre and will be mailing your Assignment Booklet to ADLC, you may return this questionnaire with the Assignment Booklet.

Instructional Design and Development
Learning Technologies Branch
Box 4000
Barrhead, Alberta
T7N 1P4

APPENDIX

Glossary
Suggested Answers
Maps

Glossary

amino acids: organic acids containing NH_3

ammonium: a charged particle containing one nitrogen atom and four hydrogen atoms; NH_4^+

aquifers: subsurface layers of porous material that collect, store, or transmit water

arable: suitable for tilling or cropping

bedrock: underlying consolidated rock

crystalline: composed of molecules arranged in a definite repeating internal structure; crystal-like

elements: smallest units of matter retaining individual characteristics

feces: bodily wastes

field capacity: the point at which the soil holds its maximum amount of water

horizons: horizontal layers of soil

inorganic: not of plant or animal origin

leach: dissolve out by the action of a percolating liquid

lignin: organic hardening agent found in wood cell walls

lustre: shiny surface

mixed wood: areas where a mix of coniferous and deciduous trees grow

nitrate: salt or acid containing NO_3

nutrient: substance that promotes growth

parkland: areas with a mix of grassy glades and trees

pathogens: viruses or bacteria that cause diseases

percolate: ooze or flow through

profile: side view

rills: very small streams of water

sandstone: sedimentary rock composed mainly of sand

saturation: the point at which the soil can hold no more water

The excess drains off.

shale: sedimentary rock composed mainly of silt and clay

solvent: substance that can dissolve other substances or form solutions with other substances

stubble: crop stems left standing after harvest

till: hard-packed clay containing sand, rocks, and boulders

transpiration: the passage of water vapour from a living body through a membrane or pore

unconsolidated: loose, unattached

water cycle: the circulation of water on Earth through three stages: evaporation, condensation, and precipitation

wilting point: the point at which soil holds so tightly to water that plants cannot get enough water for their use

Suggested Answers

Section 1: Activity 1

1.

Community	Precipitation Range (mm)	Region west, central, east	Closest Summer Air Flow
Red Deer	457 – 508	central	between moist and dry
Kananaskis	610 +	west	moist
Hinton	508 – 559	west	moist
Edmonton	457 –508	central	between moist and dry
Grande Prairie	406 – 457	west	mild
Calgary	406 – 457	west	between moist and dry
Lethbridge	356 – 406	central	warm, dry
Medicine Hat	305 – 356	east	warm, dry

2. If the Rocky Mountains didn't exist, Alberta's climate would be different. For one thing, it would get more precipitation. There would be nothing to block moist air from flowing from the Pacific Ocean. It would also have milder temperatures. Warm air from the Pacific Ocean would not be pushed high into the atmosphere, nor would it have to cross snow-capped mountains and mountain ice fields.

3. Your answers will depend on where you live. If you lived in Barrhead, Alberta, you would list the Paddle River as the source of your drinking water. Other surface waters nearby include the Pembina River.

4. One reason why major cities in Alberta are located where they are is because that is where they are close to a good supply of surface water.

5. An aquifer is a layer of porous material under Earth's surface that collects, stores, and transmits water.

Section 1: Activity 2

1. The following are three states of water and an example of where each state can be found in the home:

   - solid – ice cubes
   - liquid – wash water
   - gas – steam escaping a boiling pot

2.

Label	Name	Description
A1	transpiration	evaporation of water from plants
A2	evaporation	evaporation of water from land
A3	evaporation	evaporation of water from rivers or streams
A4	evaporation	evaporation of water from lakes
B	condensation	condensation of water vapour to form raindrops or snowflakes in clouds
C	precipitation	falling of water to Earth as rain, sleet, snow, or hail

Section 1: Activity 3

1. Your answer will depend on where you live. If you live near Peace River, you would find that you live in an area that usually has adequate moisture for crops. On the other hand, if you live near Medicine Hat, you would find that you live in an area where moisture is severely limiting for crops.

2. Rainfall is a limiting factor for Lethbridge and Medicine Hat.

3. Lack of moisture around Medicine Hat could be caused by the following:

   - Warm, dry air flows in summer cause water to evaporate.
   - There is a lack of precipitation; the area receives under 400 mm of precipitation in a year.

4. Most crops grown on irrigated land in Alberta are field crops such as wheat. Field crops are not suited to gravity irrigation methods.

5. Your answers will vary depending on the irrigation method you chose. If you chose the side-wheel roll method, your answer might be as follows.

   One method of irrigation is the sprinkler side-wheel roll method. This method takes water from irrigation canals and pumps it onto lands through a straight pipe. Wheels are attached to the pipe with the pipe acting as an axle. An advantage of this system is that it is an effective method of providing needed water to crops. A limitation of this system of irrigation is that you cannot use it to water crops that grow more than a metre high.

6. Three methods of conserving soil moisture are summerfallowing, zero tillage, and trapping winter snowfall.

7. Three problems associated with too much water include the following:

   - Crops drown if the soil remains saturated for long periods of time.
   - Wet soils interfere with field work—delay seeding, weeding, fertilizing, and harvesting operations.
   - Soil erosion is bound to increase as water drains from fields.

8. a. Agricultural production would increase. Consolidating small water bodies into a large one would make more farmland available for cultivation.

   b. Wildlife habitat would decrease in drained areas while it may increase where the water is collected.

Section 1: Activity 4

1. Water is an essential material. Without it, plants and animals die. Alberta has enough water to meet its current requirements, but that isn't to say that that will always be the case. To avoid water shortages in the future, it is important to manage current supplies. Government restrictions are needed to reduce waste and conserve the current water resources.

2. The purpose of the 1894 Irrigation Act was to promote irrigation development, regulate other water uses, and allocate the rights to all waters to the Government of Canada.

3. The priority would go to the person seeking water for irrigation purposes.

Section 1: Activity 5

1. Two hazards of improperly handling animal wastes include

    - surface-water pollution (smelly, plant-choked water unsuitable for aquatic life like fish)
    - drinking-water pollution (nitrate poisoning: stomach cancer and blue baby syndrome)

2. Your plan for disposing of animal wastes should contain these points:

    - collection procedure: either scraping wastes into piles or flushing them into pits
    - disposal procedure: spreading it on fields and immediately incorporating it into the soil

3. a. Some advantages of tilling include the following:

    - loosens the soil
    - mixes air into the soil
    - kills weeds
    - creates ridges and pockets that trap run-off waters

    b. Some disadvantages of tilling include the following:

    - leaves the soil exposed to wind and water erosion
    - dries the surface layer of soil
    - costs money for fuel and equipment

4. Polluted surface waters would not be attractive to tourists for the following reasons:

    - Polluted waters are usually turbid and foul smelling, caused by an abundance of decaying plant matter.
    - Polluted waters have more algae and other aquatic plants than other waters.
    - Polluted waters contain fewer game fish than other waters.
    - Tourists are attracted to clean, clear, weed-free waters.

5. Things to do to reduce the risk of water pollution by agricultural chemicals include

    - not spilling chemicals
    - disposing of containers in approved manner
    - using proper applicator equipment
    - spraying on calm days
    - using chemicals that lose potency quickly
    - reducing usage of chemicals in favour of other ways to control pests; e.g., tillage or biological control

Section 1: Activity 6

1.

Livestock	Litres/Day/Head	Total Litres/Day
50 cows	154.0	7700.0
2 bulls	97.0	194.0
14 steers	51.0	714.0
200 pigs	6.0	1200.0
75 chickens	0.3	22.5
Total		9830.5

2. a. Crops would not grow. Plants need water to carry out the photosynthesis process. The sugars produced during photosynthesis are used to make new plant material. Without water, no growth would occur.

   b. Animals would not grow. They may even waste away. Without water, plants will not grow; therefore, animals cannot obtain food. Without water, animals' own bodies would not function properly. Less water means less water for perspiring, so they would not be able to cool themselves. They would also have a hard time excreting wastes.

   c. Humans would find it difficult, too. Their food supply would diminish as plants and animals perished. Farmers' incomes would drop. In severe cases, humans would have to move to another area with a more hospitable climate to prevent themselves from dying.

3. In answering this question you may have made some of the following comments:

   - Water is used by plants in the photosynthesis process to produce simple foods.
   - Plants also need water to absorb soil nutrients.
   - Since plants are at the base of the food chain, all animals rely on plants for food.
   - Animals need water to excrete wastes and to act as a coolant in maintaining body temperatures.

Section 1: Follow-up Activities

Extra Help

1. Hans was concerned that wastes from his hog operation might find their way into surface-water resources and ground-water resources.

2. Some potentially harmful elements contained in manure are bacteria, salts, and nitrates.

3. It is especially serious to contaminate ground-water supplies because contaminated ground waters are close to impossible to clean.

4. Negative effects of large quantities of animal waste entering the Peace River that Kala identified were as follows:

   - Waste in the river would make the water unfit for animal or human consumption.

- Waste in the river would increase aquatic plant growth, making the river uninhabitable for fish and other aquatic organisms.

- Decreased water quality and increased aquatic plant growth would result in reduced use of the river for recreation.

5. Kala recommended that Hans construct a waste pit or lagoon to collect and store hog waste. The pit should be dug into the ground and lined with 50–100 cm of clay. Every so often, the liquid manure should be spread on Hans' land and immediately worked into the soil.

Enrichment

1. People in urban centres can make use of conservation devices, such as low-flow showerheads. Lawns and gardens can be watered during evening hours to cut down on the loss of water through evaporation. It is also possible to make use of conservation watering systems, which deliver water to plants at a slow, steady rate so it is used more efficiently. In addition, water can be conserved by using organic mulches or landscape fabrics to trap precipitation and prevent evaporation from the soil.

2. Advantages you may have thought of for practising water conservation in urban settings include the following:

    - Less water is used.
    - Less water needs to be produced for consumption.
    - Less water needs to be treated.
    - Less water means less costs for consumers and governments.

Section 2: Activity 1

1. A mineral is a solid, crystalline, naturally occurring, inorganic substance.

2. Minerals come from rock.

3. Some ways that minerals help plants grow include the following:

    - supply essential nutrients
    - physically support plants
    - anchor plants in place
    - protect roots from drying

4. Organic matter is plant or animal matter in various stages of decomposition.

5. Some ways that organic matter helps plants grow include the following:

    - stores plant nutrients
    - holds soil particles together, reducing erosion
    - creates spaces that can hold air and water by holding soil particles together
    - creates spaces that are needed for air exchange
    - collects and holds water

6. Air is composed of gases, moisture, and dust.

7. Some ways that water is used to cool things include the following:

    - ice used to cool soft drinks
    - water used in radiators to cool engines
    - water used in coal and nuclear power plants to cool equipment
    - water splashed on fires to cool the burning material
    - ice used to reduce swelling in sports injuries

8. Some ways that water is used to heat things include the following:

    - boiling water used to cook foods
    - hot water or steam used to heat buildings
    - steam or boiling water used to sterilize canning jars

9. Some ways water helps plants to grow include the following:

    - Water aids in the weathering of rock into unconsolidated mineral material, which is the base for soil.
    - The only way plants can absorb a majority of the nutrients they require is through their roots in a water solution.
    - Some plants rely on water to provide them with structural strength. Their stems and other parts become firm when cells within them are filled with a fluid composed mainly of water.
    - Plants take advantage of water's ability to absorb heat energy to cool themselves much like you do when you sweat.
    - Plants use water to dissolve and carry wastes from their cells.
    - Plants use water to dissolve and carry starches and sugars to and from living cells.
    - Other living organisms that help plants grow, such as those that break down organic matter, need water to live.
    - Plants use water in the photosynthesis process.

10. Some ways that living organisms help plants grow include the following:

    - They assist in the decomposition of organic matter, converting it into components that plants can use.
    - They defecate and their feces are incorporated into the soil.
    - They die and their bodies are incorporated into the soil.
    - They tunnel through soil making spaces for air and water to enter.
    - They dig in the soil bringing new minerals to the surface.
    - Certain bacteria are able to take nitrogen from the air and change it into a form that plants can use.

Section 2: Activity 2

1. Glacial till is composed of clay, silt, sand, stones, cobbles, and boulders. In Alberta, glacial till has a high calcium carbonate content. Glacial till formed as glaciers gouged and scratched their way across bedrock.

2. Most vegetation should grow where precipitation rates are highest: in the northern and western regions of the province.

3. The most chemical weathering of mineral materials should take place in the warmer, wetter areas of the province, e.g., along the Peace River.

4. Grassland soils have more organic matter incorporated in their lower regions than do forest soils.

Section 2: Activity 3

1. Soil scientists classify soils by looking at their profiles.

2. The darkest soil horizon is the A horizon because it contains the greatest amount of organic matter.

3. A black chernozemic soil has a thicker, darker-coloured A horizon than a brown chernozemic soil.

4. Black chernozemic soils are the best soils for agricultural purposes because they have the best mix of organic matter and mineral content. Organic matter improves production by supplying plant nutrients, improving soil structure, and storing soil moisture.

Section 2: Activity 4

1. Fertilizers are applied to soils in response to the problem of loss of soil nutrients. Fertilizers contain essential soil nutrients that are meant to replace nutrients removed from the soil because of cropping.

2. Farmers have used these four types of fertilizers over the years: manure, green manure, compost, and chemical fertilizers.

3. If you had 100 kg of 21-11-0-0 fertilizer you would have 21 kg of nitrogen.

4. The advantages of using commercial fertilizers over organic fertilizers include the following:

    - Commercial fertilizers are readily available in commercial quantities.
    - Commercial fertilizers have known amounts of soil nutrients.
    - Commercial fertilizers supply nutrients that are immediately available to plants.

5. The advantages of using organic fertilizers over commercial fertilizers include the following:

    - Organic fertilizers add organic matter to soils, while commercial fertilizers may lead to reduced organic matter in soils.
    - Organic fertilizers reduce soil acidity, while commercial fertilizers increase soil acidity.
    - Organic fertilizers increase available moisture to plants.
    - Organic fertilizers are cheaper to obtain.

6. A farmer would summerfallow for the following reasons:

   - to increase soil-moisture content
   - to reduce the risk of disease transfer from one year to the next
   - to mechanically control weeds
   - to increase the buildup of plant nutrients
   - to reduce insect pest populations

7. Factors that affect wind erosion include

   - Wind velocity – The greater the wind velocity, the more energy it has to lift and carry soil particles.
   - Soil structure – The better the soil holds together, the less likely it will suffer from wind erosion. Remember, the greater the organic matter in the soil, the better its soil structure. Any practice that increases soil organic matter content will help reduce wind erosion.
   - Soil moisture – Wet soils are held together by their water content, so they are less susceptible to wind erosion.
   - Plant covering – Any type of plant covering reduces wind erosion because the upper portions of the plants push the wind up and away from the soil surface, and the roots hold the soil particles in place.
   - Field size – The larger the field, the more area is open to wind erosion.

8. You may have chosen to write about shelterbelts, strip cropping, cover crops, or zero tillage. Here are some of the statements you might have included in your paragraph if you chose to write about shelterbelts.

   Shelterbelts are rows of trees planted in the path of prevailing winds. Shelterbelts protect soil from wind erosion by taking some of the force out of the wind. A shelterbelt that is 3 m high has the ability to reduce wind velocity for 60 m on the lee side.

9. You may have chosen to write about grassed waterways or contour cultivation (or any of the previous four methods discussed for preventing wind erosion) as a response to water erosion. Here are a few statements you might have included in your paragraph.

   Grassed waterways are natural drainage paths that have been seeded to permanent grasses. Grasses hold soil in place during wet periods when water is moving off the field. Grasses also trap soil carried by water from other parts of the field so it is not completely removed from the field.

Section 2: Follow-up Activities

Extra Help

1. a. living organisms
   b. organic matter
   c. living organisms
   d. minerals
   e. organic matter
   f. minerals
   g. water
   h. air
   i. air
   j. water

2. Alberta soils developed from glacial till.

3. Alberta has a cool, temperate climate.

4. Grassland soils have more organic matter incorporated in their lower regions than forest soils. The reason is that grasses send out deep, fibrous roots to collect moisture during dry spells. These root systems are responsible for the buildup of organic matter in the soil's lower regions.

Forest soils, on the other hand, have less organic matter in the lower regions. Forests grow where there is an abundance of moisture. Most of the root systems of forest plants grow near the surface. They do not have to go deep into the soil to get water.

Another reason for forest soils having less organic matter in the lower regions is that forest plants are woody. They are composed of materials that do not break down quickly. This means that the organic matter that does collect at the soil surface remains there for long periods of time without being incorporated into the soil.

5.

Soil Group	Map Letter
brown chernozemic soils	A
dark-brown chernozemic soils	B
black chernozemic soils	C
dark-grey chernozemic soils	D
grey luvisolic soils	E

6. You may have chosen to write about loss of soil nutrients. If you did, the following points might have been included in your answer:

- Soil has a limited amount of nutrients.
- Crops use the nutrients. Because some of the plant material is removed from the field in cropping practices, there is a steady decline in soil nutrients.
- Two responses to this problem are applying fertilizers to the soil and summerfallowing.
- Fertilizers contain essential plant nutrients.
- There are organic fertilizers such as animal manure, green manure, and compost.
- Chemical fertilizers are readily available and they are the most widely used.
- Summerfallowing rests the soil allowing plant nutrients to be replenished through the decomposition of organic matter.

If you chose to write about soil erosion, you may have included these statements in your answer.

- Soil erosion happens when soil particles are moved by wind or water to new locations.
- Wind and moving water can remove soil particles from a field, thus robbing the soil of mineral nutrients and organic matter.
- Any agricultural practice that exposes the soil to wind or moving water promotes erosion.
- Responses to wind erosion include shelterbelts, strip cropping, cover crops, and zero tillage.
- Responses to water erosion include shelterbelts, strip cropping, cover crops, zero tillage, grassed waterways, and contour cultivation.

Enrichment

1. Did you enjoy composting? Did you have any problems with your compost pile? How long did it take for your compost pile to change from plant material into the dark, soil-like material? You probably found that this was an easy way to dispose of unwanted plant material and that you gained satisfaction out of being able to return something to Earth.

2. You probably noted that most large cities are located in the middle of prime agricultural land because those communities were initially set up to cater to the needs of local farmers. Farmers had to be supplied with goods and services. The better the land, the more farmers settled in the area and their needs had to be looked after. In addition, they would produce more goods that needed to be stored, processed, and shipped. Therefore, the better the land, the more commercial activity would take place in nearby communities and the larger those communities became.

3. What did your plant material look like after five days? Was it shrivelled and dried out? Was it covered by fungi? Did it completely disappear? Did your worms survive? Be sure to return them to the spot you found them.

Section 3: Activity 1

1. a. urban development
   b. oil and gas extraction
   c. wildlife habitat
   d. transportation
   e. recreation

2. Your answer will vary depending on how you rank agriculture and urban-development uses of land. If you think that urban development is more important than agriculture, you would reply no. Urban development is necessary because people need places to live and work.

   If, on the other hand, you see that there is only so much good farmland and that urban developments should take avenues other than using good farmland, you would reply yes. Farmland is needed to produce the food and other goods people must have to survive. You may even refer to countries like Israel where towns and cities are built on hilltops to avoid covering fertile valley soils.

3. If you answered yes to question 2, you may explain that urban development could continue vertically. Taller buildings constructed closer together would meet the need for more homes and more office buildings. You might also point out that urban development should be channelled into less-fertile areas, with new communities being constructed on less-productive farmlands.

   If you answered no to question 2, you might explain that topsoil from lands appropriated for urban development could be moved onto other farmlands. That way no fertility losses would occur. You might also argue that urban centres cover such a small proportion of lands that it isn't worth worrying about the loss of farmland. This last argument may not be sound, but it may put your opponents on the defensive, looking for statistics on how much good farmland is lost due to urban sprawl each year.

4. The biggest advantage of creating a reservoir is that the water can be used for many purposes including irrigation, drinking water, recreation, industrial processing, and creating electricity.

5. Disadvantages of creating a reservoir include the high cost of construction and the fact that water covers lands that could be used for other purposes like agriculture production or wildlife habitat.

6. Decisions that Parks Canada made that would have a positive effect on wildlife habitat include the following:

   - Buffalo Paddock cadet camp, air strip, and horse corrals will be removed.

- Mountain hiking trails around Johnson's Lake will be closed.
- No new hotels or hostels will be developed.
- Lake Louise will remain a visitor service centre with overnight accomodation capped at 3500, and no new development will be allowed.
- Summer-use proposals at Banff Mount Norquay will not be allowed.

Section 3: Activity 2

1. The environmental impact study conducted for the Cheviot Mine should

   - look at the need for the project
   - examine all land-use options
   - evaluate the environmental damage to plants, animals, streams, etc., that may result from the project
   - suggest how to eliminate or reduce environmental damage caused by the project

2. If you said you would vote for the project, these are some reasons you might give to explain your decision:

   - The new mine would allow for an extension of the economic benefits enjoyed by the community of Hinton.
   - It would save jobs that would be lost when the old mine closes.
   - Land used in the strip-mining operation would be returned to a natural state after the coal had been extracted.
   - The sale of coal to other nations would contribute to Canada's favourable balance of trade.

   If you said you would vote no on the proposed mine, these are a few of the reasons you might give for your decision:

   - Mining would disrupt the environment for years.
   - It would be impossible to return the land to its original condition.
   - Eroded soil would move from the mine site into local streams, clogging them and inhibiting aquatic life.
   - Coal from the mine would be burned, creating air pollution and increasing the problems associated with global warming.
   - Mining would reduce tourism.
   - The mine would be too close to Jasper National Park and may detract from the park's natural beauty.

3. Government planners go through much the same process as when they are deciding on any other land-use issue. They establish a committee to examine the question.

   Consider the Fort Assiniboine Sandhills Wildland Park established by the Government of Alberta in 1997. After 10 years of consultation with different land users, a plan was developed setting aside some land for wildlife habitat, some for off-highway vehicle use, and some for commercial use.

4. Recreational areas in your region might include

    - wildland, provincial, national, and municipal parks
    - water reservoirs, lakes, and rivers
    - non-designated Crown lands
    - ski-hills, golf courses, baseball diamonds, hockey arenas, and fairgrounds

5. A person wanting to know more about how a piece of land may be used can go to the local government and ask for land-use bylaws affecting that property.

Section 3: Activity 3

1. Your advice to Karen should take into account the best use for the land, Karen's financial situation, and her personal goals. The option that best fits these criteria is Option A. It allows her to improve the open land by growing a cover crop. It keeps her debt to a minimum. It would also be more in keeping with her desire to be a good steward of the land by allowing her to keep the marshland intact.

    Although it does not fully satisfy her goal of raising another 50 animals, it does allow her to expand slowly by increasing by 20 animals. Expanding gradually would help her work out any management problems that may come about because of her expansion.

    Option Z would not be the best for Karen. It would put the land at greater risk of being eroded. It would put Karen deeper in debt, and it would mean a rapid change in her management practices. It also goes against her desire not to overexploit the land.

    Of course, Karen could decide to do something in between the two options presented. For example, she could clear part of the forest land and expand her pasture area. This might allow her to raise a few more animals. You may have suggested this in your answer.

2. Here are two things Karen might consider doing to the land in the near future. One is to open part or all of the southeast corner of the property. She could sell timber on that portion for about $5000. The money could go towards breaking the land so she could expand her pasture or possibly grow feed crops on that land in the future.

    Another thing she may consider in the second year is putting in a green-manure crop on the open land to help restore its organic-matter content.

3. Planning and research are necessary when making a decision on land use to

    - clearly identify the land in question
    - identify the possible uses for the land
    - inform all interested parties about the upcoming decision
    - hear from all interested parties
    - identify harmful effects of proposed uses
    - ensure neighbouring lands are not harmed by land usage
    - avoid conflicts between users
    - avoid depletion of natural resources
    - ensure common resources are shared equally

    In Karen's case, it provided her with a better understanding of the land she purchased. She found out that the open land was in bad shape. She also became aware of the marshland. She could then plan what she would do to restore the depleted land and retain as much wildlife habitat as possible.

4. Two advantages of draining the marshland include

   - cultivated area increases
   - efficient use of field equipment increases

   Two disadvantages of draining the marshland include

   - wildlife habitat decreases
   - risk of erosion increases

Section 3: Follow-up Activities

Extra Help

1. *Lobby* is defined as an activity that is designed to influence or win over government representatives to a certain point of view.

   A lobby group would be a group of people who have a certain point of view and try to influence government representatives to adopt that point of view.

   Lobby groups hold views about land use and try to influence those making decisions about land use to rule in their favour.

2. The two user groups that were in conflict in the case of the Wagner Natural Area were Alberta Transportation, who proposed building an overpass and service road next to the area; and an environmental group, who opposed the project. The environmental group foresaw potential danger to the natural preserve affecting water supply to the natural area and damaging plant forms rare in the area.

3. The environmental impact study revealed that if the project went through it would indeed harm the Wagner Natural Area. However, it did find that if the project was moved further east, damage to the area would be minimized, yet it would provide the needed improvement to the transportation route.

4. The issue was resolved by building the overpass and service road further east as recommended in the environmental impact study.

Enrichment

1. a. To preserve a forest of prime timber, you could limit the number of trees cut each year and require reforestation of cut areas.

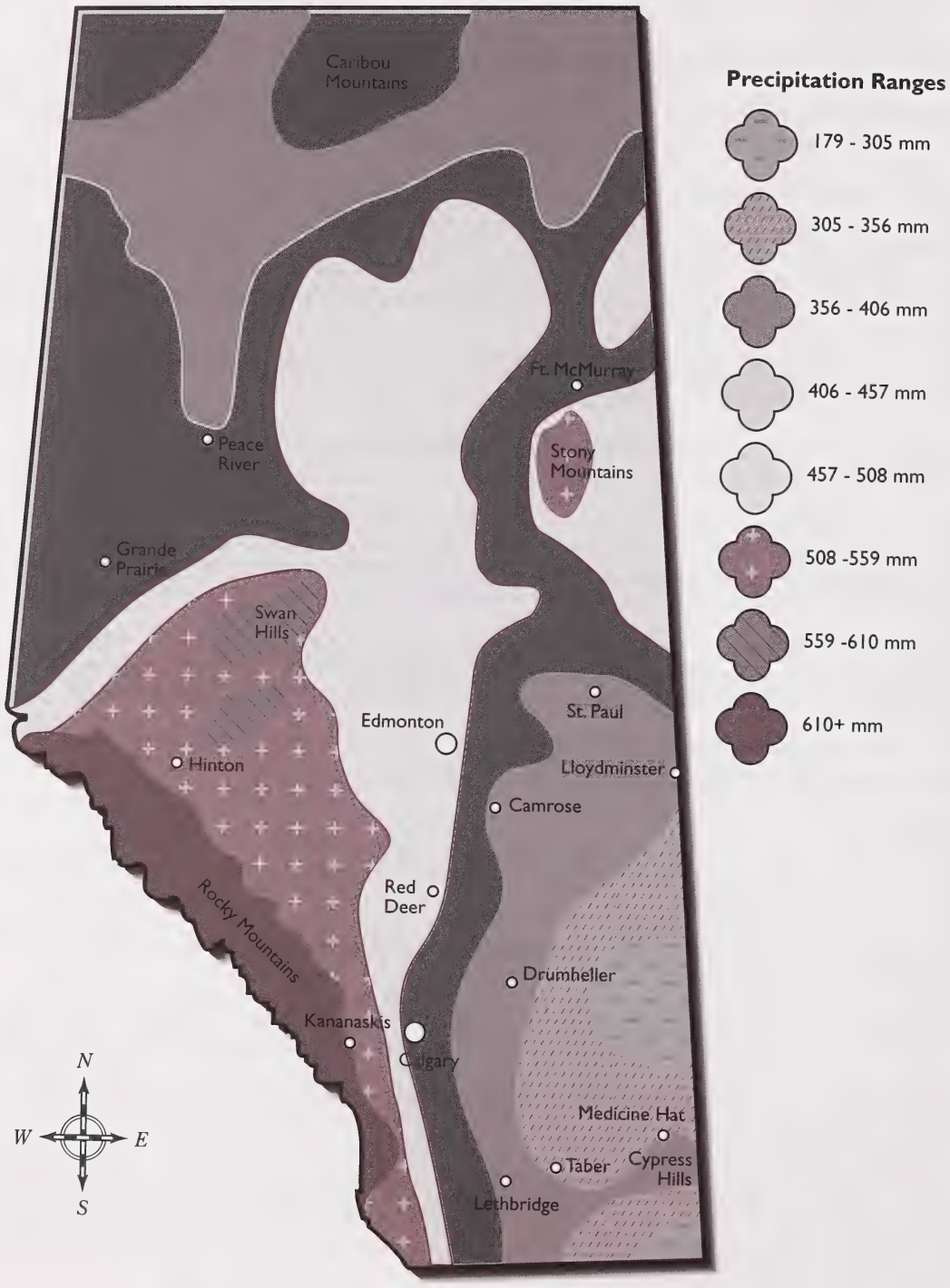
   b. To preserve the farmland, remove all topsoil from the site before mining begins; then replace the soil when the mine closes.

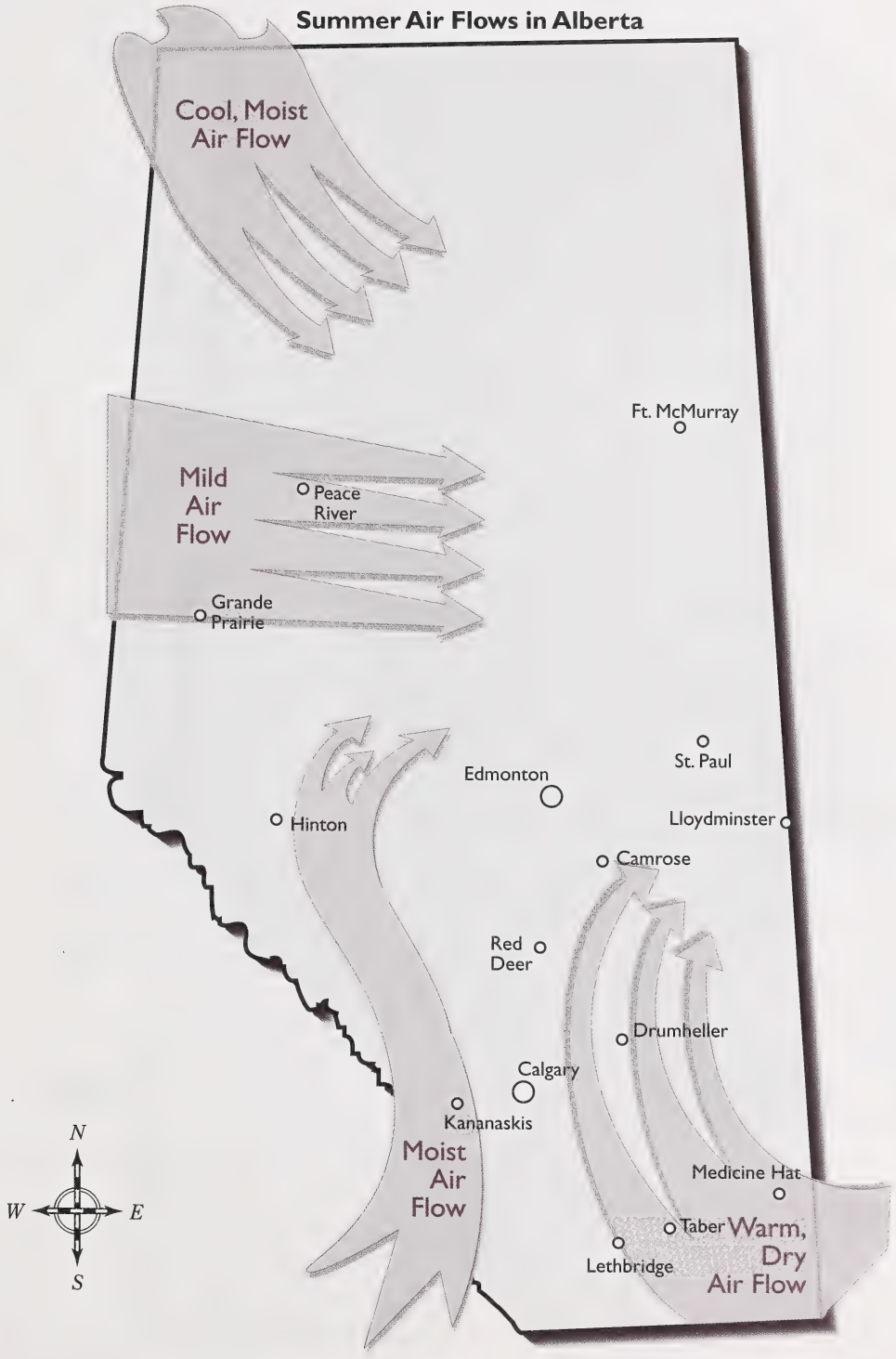
   c. To preserve the wilderness area, transportation systems must be held to a minimum, natural water flows should be maintained as much as possible, and animal migratory routes must be kept clear.

2. The information you obtain from Ducks Unlimited will vary depending on your area. However, you should learn from this group about the management of waterfowl habitats and the work the group does in your region.

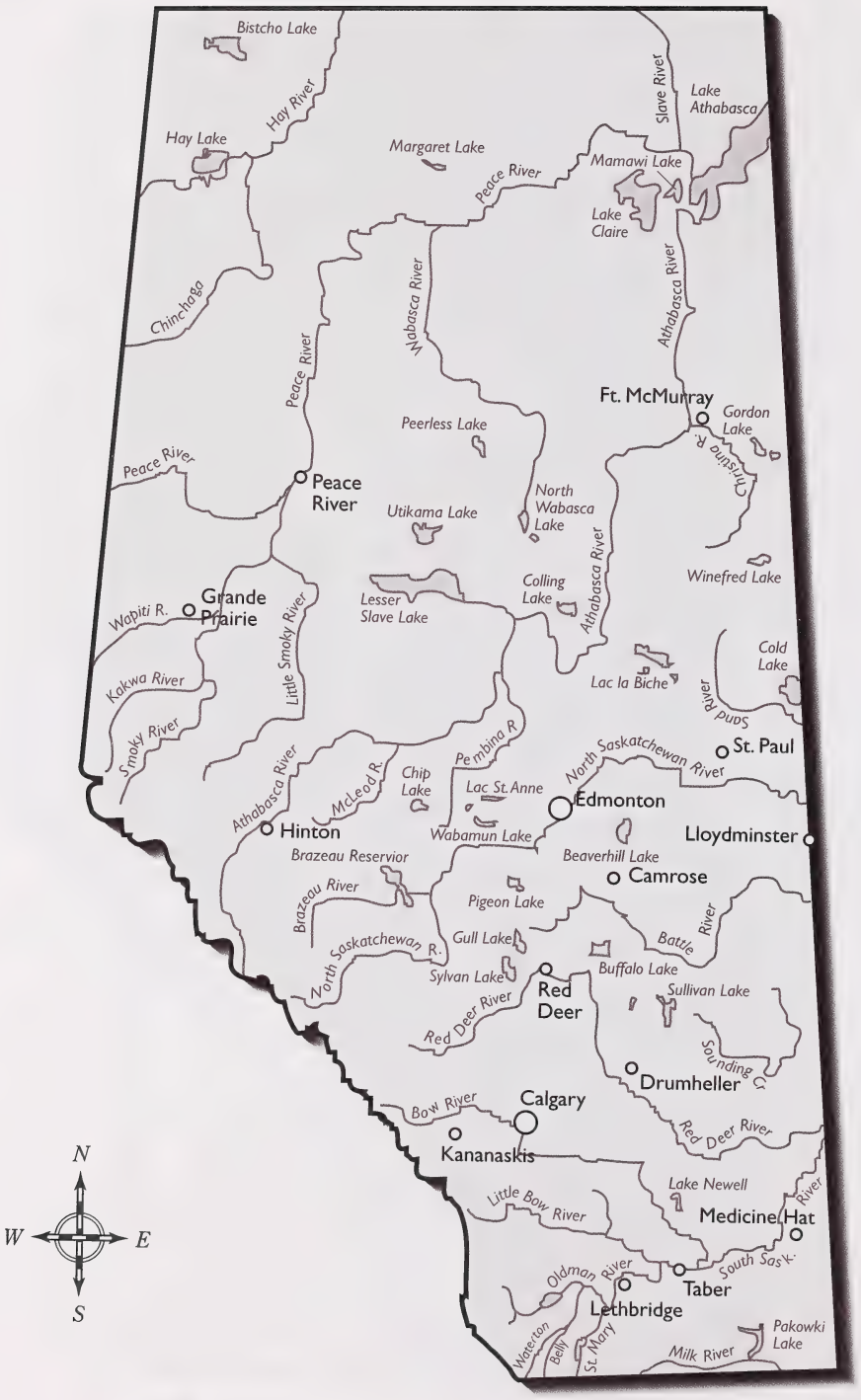
3. Did you have fun building your model city? Were you able to keep the citizens happy? Don't feel bad if they turned against you. Some of their demands conflict with each other. For example, the desire for better transportation routes conflicts with citizens' demands for lower taxes. As many politicians will point out, doing what is right isn't necessarily doing what is popular.

Mean Annual Precipitation in Alberta

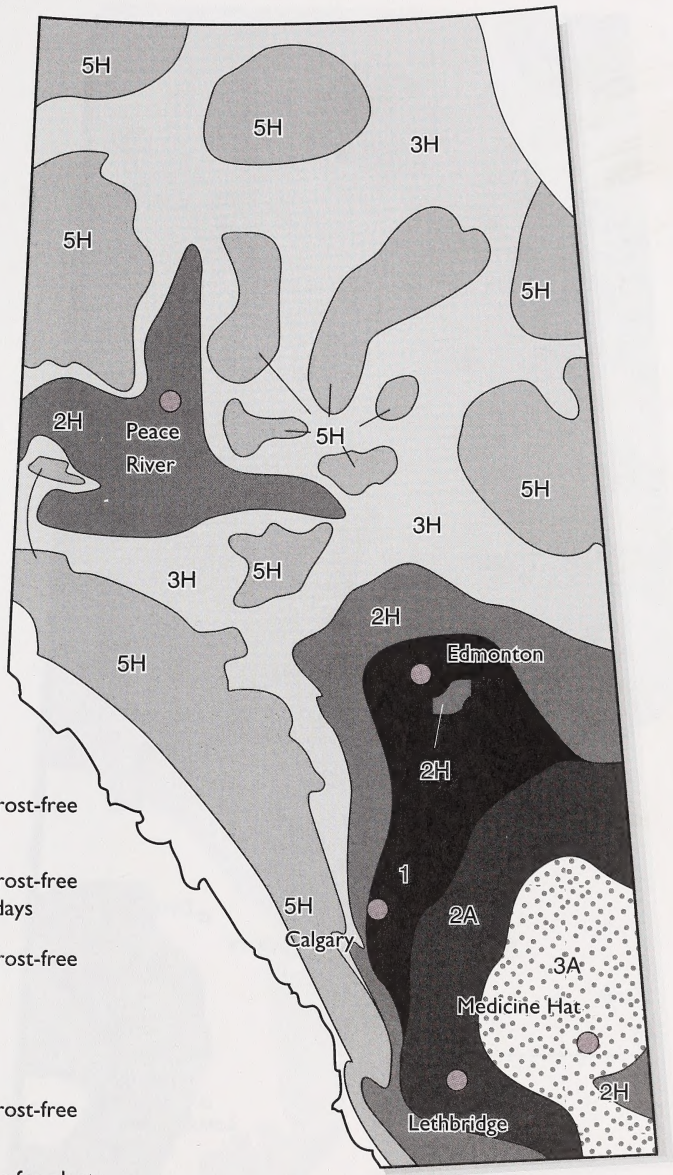



Summer Air Flows in Alberta
Cool, Moist Air Flow
Ft. McMurray
Mild Air Flow
Peace River
Grande Prairie
St. Paul
Edmonton
Hinton
Lloydminster
Camrose
Red Deer
Drumheller
Calgary
Kananaskis
Moist Air Flow
Medicine Hat
Taber
Warm, Dry Air Flow
Lethbridge
N
W
E
S

Lakes and Rivers in Alberta



Climate Map of Alberta



3H — Rainfall adequate – frost-free period 60–75 days

5H — Rainfall adequate – frost-free period less than 60 days

2H — Rainfall adequate – frost-free period 70–90 days

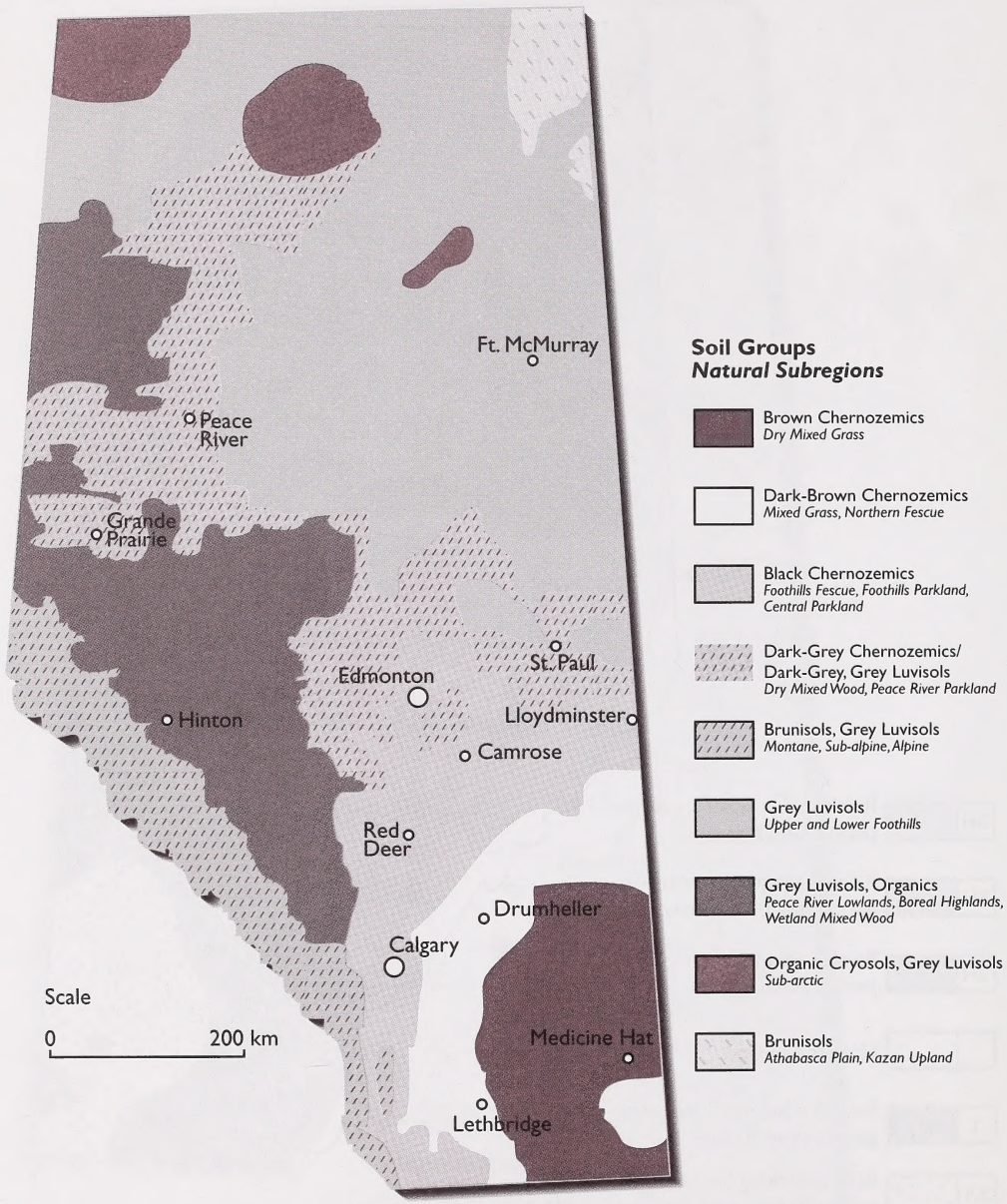
Unclassified land

1 — Rainfall adequate – frost-free period over 90 days

3A — Rainfall limiting factor for plant growth – frost-free period over 100 days

2A — Rainfall limiting factor – 50% of time for plant growth; frost-free period over 100 days

Soil Group Map of Alberta



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